R10-TP-82
SB761
.A3
A4
1999

United States
Department of
Agriculture

Forest Service
Alaska Region
R10-TP-82
February 2000

State of Alaska
Department of
Natural Resources
Division of Forestry

Forest Health Protection Report

Forest Insect and Disease Conditions in Alaska--1999

FORESTRY SCIENCES LABORATORY
2770 SHERWOOD LANE, SUITE 2A
JUNEAU, ALASKA 99801-8545

ALASKA FOREST HEALTH SPECIALISTS

Anchorage

Forest Health Protection
USDA Forest Service
State and Private Forestry
3301 'C' Street, Suite 522
Anchorage, AK 99503-3956
Phone: (907) 271-2575
FAX (907) 271-2897

Jerry Boughton, Program Leader
email: jboughton@fs.fed.us
Edward H. Holsten, Entomologist
email: eholsten@fs.fed.us
Beth Schulz, Ecologist
email: bschulz@fs.fed.us
Lori Trummer, Pathologist
email: ltrummer@fs.fed.us
Kenneth P. Zogas, Biotechnician
email: kzogas@fs.fed.us
Kathleen Matthews, Biotechnician
email: kmatthews03@fs.fed.us

Department of Natural Resources
State of Alaska
Division of Forestry State Office
550 W 7th Avenue, Suite 1450
Anchorage, AK 99501-3566
Phone: (907) 269-8460
FAX (907) 269-8902 / 8931

Roger Burnside, Entomologist
e-mail: rogerb@dnr.state.ak.us

Alaska Cooperative Extension
2221 E. Northern Lights, Suite 118
Anchorage, AK 99508
Phone: (907) 786-6311

Fred Sorenson, IPM Program Coordinator
e-mail: dffes@uaa.alaska.edu

Juneau

Forest Health Protection
USDA Forest Service
State and Private Forestry
2770 Sherwood Lane, Suite 2A
Juneau, AK 99801
Phone: (907) 586-8883
(907) 586-8769
FAX (907) 586-7848

Paul E. Hennon, Pathologist
email: phennon@fs.fed.us
Mark Schultz, Entomologist
email: mschultz01@fs.fed.us
Dustin Wittwer, Biotechnician
email: dwittwer@fs.fed.us

FOREST INSECT AND DISEASE CONDITIONS IN ALASKA -- 1999

General Technical Report R10-TP-82

February 2000

Compiled by:
Dustin Wittwer, Biological Technician

Contributors:
Kathleen Matthews, Biological Technician
Ken Zogas, Biological Technician
Lori Trummer, Pathologist
Ed Holsten, Entomologist
Beth Schulz, Ecologist
Paul Hennon, Pathologist
Mark Schultz, Entomologist
Roger Burnside, AK/DOF Entomologist
Dorothy Mortenson, AK/DNR GIS
Jeff Riggs, AK/DNR GIS Analyst
Alaska Cooperative Extension

Forest Health Protection
State and Private Forestry
Alaska Region
USDA Forest Service
3301 "C" Street, Suite 522
Anchorage, Alaska 99503

State of Alaska
Department of Natural Resources
Division of Forestry, State Office
550 W. 7th Avenue, Suite 1450
Anchorage, Alaska 99501-3566

Table of Contents

CONDITIONS IN BRIEF 1
THE ROLE OF DISTURBANCE IN ECOSYSTEM MANAGEMENT 5

STATUS OF INSECTS 8
INSECTS AS AGENTS OF DISTURBANCE 8

BARK BEETLES 9
Spruce Beetle 9
Engravers 11

DEFOLIATORS 14
Spruce Needle Aphid 14
Western Black-headed Budworm 14
Hemlock Sawfly 15
Spruce Budworm and Coneworm 15
Larch Sawfly 15
Birch Defoliation 16
Large Aspen Tortrix 16
Gypsy Moth 17
Cottonwood Leaf Beetle 17
Willow Leaf Blotchminer 17
Alder Woolly Sawfly 18
Spotted Tussock Moth 18

MISCELLANEOUS FOREST INSECTS 18
Hawkmoth 18
Sitka Spruce Weevil 18
Spider Mites: Acarina 19

STATUS OF DISEASES 24
ECOLOGICAL ROLES OF FOREST DISEASES 24

STEM DISEASES 27
Hemlock Dwarf Mistletoe 27
Hemlock Canker 28
Spruce Broom Rust 28
Western Gall Rust 28

HEART ROTS OF CONIFERS 28

STEM DECAY OF HARDWOODS 30

SHOOT BLIGHTS and CANKERS 30
Sirococcus Shoot Blight 30
Shoot Blight Of Yellow-cedar 31
Canker Fungi 31

FOLIAR DISEASES 31
Spruce Needle Blights 31
Spruce Needle Rust 31

Hemlock Needle Rust 32
Willow Rust 32
Foliage Diseases of Cedars 32

ROOT DISEASES 33
Tomentosus Root Disease 33
Annosus Root & Butt Rot 34
Armillaria Root Disease 34

DECLINES AND ABIOTIC FACTORS 35
Yellow-cedar Decline 35
Water Damage 38
Hemlock Fluting 38

STATUS OF ANIMAL DAMAGE 39
Porcupine 39
Bear 39
Moose 39
Snowshoe Hare 39

APPENDICES 41
INTEGRATED PEST MANAGEMENT 42
SUBMITTING INSECTS AND DISEASES FOR IDENTIFICATION 44
BIOLOGICAL EVALUATIONS, TECHNICAL REPORTS, AND PUBLICATIONS 45
ECOMAP SECTION DESCRIPTIONS 46
WORLD WIDE WEB LINKS 50
INFORMATION AVAILABLE FROM STATEWIDE AERIAL SURVEYS 52

LIST OF TABLES

Table 1. 1999 forest insect and disease activity in Alaska by land ownership 3
Table 2. Acreage having active insect damage, by year since 1994, and the cumulative area 4
Table 3. Suspected effects of diseases on ecological characteristics and Alaskan forests. 25
Table 4. Common wood decay organisms of live trees in Alaska 29
Table 5. Acreage affected by yellow-cedar decline in southeast Alaska in 1999. 37

LIST OF MAPS

Map 1. Ecosystem Sections Map 7
Map 2. Copper River Spruce Beetle Impact Map 12
Map 3. Kenai Sequential, 1994-1999, Spruce Beetle Map 13
Map 4. General Forest Pest Activity in 1999 21
Map 5. 1999 Survey Flight Paths Showing Ownership 22
Map 6. Cedar Decline in Southeast Alaska. 36
Map 7. USGS Quadrangle Locator Map 54

FOREST INSECT AND DISEASE CONDITIONS IN ALASKA -- 1999

CONDITIONS IN BRIEF

Aerial detection mapping is conducted annually to document the location and extent of active forest insect and disease damage. These surveys generally cover approximately 1/3 of the forested land in Alaska. Smoke from large wildfires in interior Alaska and inclement weather precluded flights into many areas of concern. Even so, approximately 31 million acres throughout Alaska were surveyed. Insect activity this year impacted the least number of recorded acres in over 8 years. The most important diseases and declines in Alaska are characterized as chronic conditions and remain relatively unchanged.

INSECTS:

Total area of active **Spruce Beetle** infestation fell again in 1999 to only 253,265 acres, continuing a decline in mapped acreage, which began in 1997. The 1999 acres represent a 19% decline from 1998 levels and a 77% decline from 1996 levels when beetle-impacted areas peaked at 1.1 million acres. Population levels in areas which have recently been heavily impacted, such as Iliamna Lake, the Copper River Valley, the west side of Cook Inlet, the Anchorage Bowl, the northern Kenai Peninsula and the eastern portion of Kachemak Bay have declined dramatically due to lack of host material. Some active areas persist, where suitable host material remains or where new areas of disturbance present the spruce beetle with fresh opportunities for population increases. Heavy activity continues near Lake Clark along the Tlikakila River and in the Hanagita River Valley in the Wrangell-St. Elias National Park and Preserve.

Total spruce beetle activity in southeast Alaska decreased from a high of 35,700 acres in 1996 to 6,556 acres in 1999, mostly in the Chilkat and Chilkoot drainages north of Haines. There were 1,424 acres of activity in Glacier Bay National Park east of Gustavus. The infestation on the Taku River near the Canadian border has almost completely collapsed.

Spruce needle aphid occurred on 4,253 acres in Southeast Alaska from the southern end of Prince of Wales Island to Tenekee Inlet, Chichagof Is. in 1999. This was a 90% reduction from 1998 acres. Sitka spruce were affected along the beach fringe and not up the slope as in 1998.

Spruce budworm activity decreased in 1999; only 708 acres of white spruce were defoliated compared to 87,800 defoliated acres last year. After more than five consecutive years, the budworm outbreak along the Yukon River appears to have run its course.

Willow leaf blotchminer defoliation rose for the second consecutive year; more than 180,396 acres of defoliated willow were aerially detected in 1999 vs. 120,000 acres in 1998. Similar to last year, most of the willow defoliation is located in the upper Yukon and Porcupine River valleys.

Acres of aspen affected by **Large Aspen Tortrix** defoliation declined by 41% in 1999 to 13,336 acres, consistent with the cyclic nature of this insect. Tortrix activity was confined almost exclusively to interior Alaska with the exception of a small, but persistent population located near Skilak Lake on the Kenai Peninsula.

Larch sawfly continues to be quite active throughout the range of larch in interior Alaska. Defoliation, however, was significantly reduced over 1998 levels. Approximately 190,000 acres of defoliated larch were detected this year vs. more than 400,000 acres of defoliated larch in 1998. In many of the defoliated areas, patches of larch mortality are beginning to appear; either due to the direct effects of the sawfly or by the larch beetle attacking stressed, defoliated trees. The major area of sawfly activity continues to be from the Alaska Range west to the Kuskokwim River. Larch sawfly was detected for the first time south of the Alaska Range in the Mat-Su Valley and Anchorage Bowl defoliating ornamental larch. This was no doubt an accidental introduction.

In southeast Alaska, **Hemlock sawfly** defoliation levels decreased over the last three years from 8,250 acres in 1996 to 89 acres in 1999.

DISEASES:

The most important diseases and declines of Alaskan forests in 1999 were wood decay of live trees, root disease of white spruce, hemlock dwarf mistletoe, and yellow-cedar decline. Except for yellow-cedar decline, trees affected by these diseases are difficult to detect by aerial surveys. Nonetheless, all are chronic factors that significantly influence the commercial value of the timber resource and alter key ecological processes including forest structure, composition, and succession. Wildlife habitat is enhanced through the development of hollow tree cavities by heart rot fungi, and witches' brooms by hemlock dwarf mistletoe and broom rust fungi.

In southeast Alaska, approximately one-third of the gross volume of forests is defective due to **stem** and **butt rot fungi**. **Hemlock dwarf mistletoe** continues to cause growth loss, top-kill, and mortality in old-growth forests; its impact in managed stands depends on the abundance of large infected trees remaining on site after harvesting. Approximately 493,000 acres of **yellow-cedar decline** have been mapped across an extensive portion of southeast Alaska. Snags of yellow-cedar accumulate on affected sites and forest composition is substantially altered as yellow-cedar trees die, giving way to other tree species. Salvage opportunities for this valuable resource are now being recognized.

In south-central and interior Alaska, **tomentosus root rot** continues to cause growth loss and mortality of white spruce in all age classes. Stem, butt, and root rot fungi cause considerable defect in white spruce, paper birch and aspen stands. Saprophytic decay of spruce bark beetle-killed trees, primarily caused by the **red belt fungus**, continues to rapidly develop on and degrade dead spruce trees.

Spruce needle rust occurred at high levels in several areas of southeast Alaska and endemic levels across south-central Alaska. **Willow rust** occurred at moderate levels in interior Alaska in 1999. Acres reported by aerial survey observers for the rust fungi should be considered conservative because the diagnostic foliar discoloration appears most pronounced on trees several weeks after survey flights. Cone and other foliar diseases of conifers were generally at low levels throughout Alaska in 1999. Canker fungi were at endemic levels, causing substantial, but unmeasured, damage to hardwood species in south-central and interior Alaska.

Other:

In localized areas of southeast Alaska, feeding by porcupines and brown bears continues to cause tree damage to several conifer species.

Table 1. 1999 forest insect and disease activity as detected during aerial surveys in Alaska by land ownership and agent[1]. All values are in acres.

Damage Agent	State & Private	National Forest	Other Federal	Native Corp.	Total 1999	*Difference From 1998*
Willow Defoliation	19,360	0	72,595	88,441	180,396	+57,326
Larch Beetle	20,256	0	3,265	6,795	30,316	+30,316
Yellow-cedar Decline[2]	23,563	449,395	323	20,462	493,743	+14,661
Birch Defoliation	324	0	2,421	8	2,753	+2,720
Water Damage	617	119	1,518	318	2,572	+1,742
Porcupine Damage	0	327	0	18	345	+265
Hemlock Canker	0	0	0	257	257	+257
Blowdown/Windthrow	18	264	114	0	396	+246
Willow Rust	309	0	17	207	533	-7
Landslide Damage	3	61	11	0	75	-145
Cottonwood Defoliation	1,745	0	1,744	2,101	5,590	-1,020
Hemlock Sawfly	18	71	0	0	89	-3,841
Engraver Beetle	226	0	347	697	1,270	-8,030
Large Aspen Tortrix	4,973	0	3,975	4,388	13,336	-8,494
Engravers/Spruce Beetle	833	0	865	810	2,508	-10,662
Spruce Needle Aphid	1,212	2,653	321	67	4,253	-42,087
Spruce Beetle	110,845	6,415	113,614	22,391	253,265	-63,535
Spruce Budworm	570	0	0	139	708	-87,092
Larch Sawfly	12,626	0	134,234	12,400	159,260	-302,520
Total Acres	**197,498**	**459,305**	**335,364**	**159,499**	**1,151,665**	**-419,900**

[1] Table entries do not include many of the most destructive diseases (e.g., wood decays and dwarf mistletoe) because these losses are not detectable in aerial surveys.

[2] Value of yellow-cedar decline is not restricted to the acreage with a high concentration of dying trees for this year; it represents stands that generally have long-dead trees, recently-dead trees, dying trees, and some healthy trees. See discussion of yellow-cedar decline for a detailed listing of affected acreage.

Table 2. Acreage having active insect damage, by year since 1994, and the cumulative area (in thousands of acres) affected for the last 6 years.

Damage Agent	1994 Total	1995 Total	1996 Total	1997 Total	1998 Total	1999 Total	Cumulative Totals[1]
Spruce beetle	610.2	893.9	1,133.0	563.7	316.8	253.3	**2195.7**
Larch sawfly	0.3	116.9	606.9	267.6	461.8	159.3	**1485.7**
Spruce budworm	232.1	279.3	235.9	38.4	87.8	0.7	**577.6**
Willow defoliation	12.5	5.6	50.1	3.5	123.1	180.4	**350.5**
Black-headed budworm	188.1	13.0	1.2	30.8	--	--	**233.4**
Large aspen tortrix	9.2	32.4	6.4	5.1	21.8	13.3	**84.8**
Engravers/spruce beetle[2]	22.5	5.6	13.9	8.8	13.2	3.9	**72.9**
Spruce needle aphid	1.5	0.1	0.5	24.8	46.4	4.3	**52.1**
Hemlock sawfly	3.0	1.1	8.3	6.6	3.9	--	**22.8**
Cottonwood defoliation	3.8	3.5	5.4	3.0	6.6	5.6	**20.7**
Birch defoliation	--	0.9	3.2	5.4	0.1	2.8	**12.2**
Total thousands acres	**1,083.2**	**1,352.3**	**2,064.8**	**957.7**	**1,081.5**	**623.6**	**5108.4**

[1] The same stand can have active infestation for several years. The cumulative total is a union of all areas for 1993 through 1998.

[2] These tallies represent polygons coded to ipb (*Ips* and spruce beetle combination) and polygons coded only to *Ips*.

THE ROLE OF DISTURBANCE IN ECOSYSTEM MANAGEMENT

To the casual observer, forests may appear to be unchanging. In fact, most forests are in some stage of re-establishment after one or more disturbances. In Alaska, geological processes, climatic forces, insects, plant diseases, and the activities of animals and humans have shaped forests. To practice ecosystem management, we must understand how these cycles of disturbances have shaped and continue to influence various forest ecosystems.

Disturbances result in changes to ecosystem function. In forests, this often means the death or removal of trees, but other forms of disturbance can be slow, gradual changes in environmental conditions. Disturbances caused by physical forces such as volcanoes, earthquakes, storms, droughts, and fire can affect the entire plant community, although some species may be more resistant to damage than others. Insects, plant diseases, animal and human activities are usually more selective, directly affecting one or several species.

Figure 1. Wind disturbance is a common precursor to other forms of disturbance such as bark beetles, fire and landslides.

Cycles of disturbance and recovery repeat over time and across landscapes. From evidence of past disturbances on a landscape, we can predict what type of disturbance is likely to occur in the future. Landscapes supporting large areas of single age stands indicate rare, but intense large-scale disturbances. Landscapes with a variety of age classes and species suggest more frequent smaller scale events. Usually, several types of disturbances at various scales of space, time, and intensity have influenced forest structure and composition on a given site. The role of disturbance in ecological processes is well illustrated in Alaska's two distinct forest ecosystem types and transition zones.

The temperate rain forests of southeast Alaska are dominated by western hemlock and Sitka spruce. Alaskan yellow-cedar, western red cedar, shore pine and mountain hemlock are also important components. Trees on productive sites can attain great size due to abundant rainfall and moderate temperatures. Wind is the major disturbance agent in southeast. Degree of impact and scale depends on stand composition, structure, age and vigor and as well as wind speed, direction, duration and topographic effects on wind flow. The forest type most susceptible to wind throw is mature spruce-hemlock on productive, wind-exposed sites. The large, top-heavy canopies act as sails and uprooting is common, resulting in soil churning, which expedites nutrient cycling and increases soil permeability. Even-aged forests develop following large-scale catastrophic wind events. Old-growth forest structure develops in landscapes protected from prevailing winds. In these areas, small gap-forming events dominate. Trees are long-lived, but become heavily infected with heart-rot fungi, hemlock dwarf mistletoe, and root rot fungi as they age. Weakened trees commonly break under the stress of gravity and snow loading. Canopy gaps generated this way do not often result in exposed mineral soil.

The boreal forests of interior Alaska are comprised of white spruce, black spruce, birch, aspen and poplar. The climate is characterized by long, cold winters, short, hot summers, and low precipitation. Cold soils and permafrost limit nutrient cycling and root growth. Topographic features strongly influence microsite conditions; north-facing slopes have wet, cold soils, whereas south-facing slopes are warm and well drained during the growing season. Soils are usually free from permafrost along river drainages, where flooding is common. Areas more distant from rivers are usually underlain by permafrost and are poorly drained. Fire is the major large-scale disturbance agent; lightening strikes are very common. All tree species are susceptible to

damage by fire, and all are adapted, to various degrees, to regeneration following fire. Fire impacts go beyond removal of vegetation; depending on the intensity and duration of a fire, soil may be warmed, upper layers of permafrost may thaw, and nutrient cycling may accelerate. Patterns of forest type development across the landscape are defined by the basic silvics of the species involved. Hardwoods are seral pioneers, re-sprouting from roots or stumps. White spruce stands are usually found on better-drained soils, along flood plains, river terraces, and on slopes with southern exposure. Black spruce and tamarack occur in areas of poor drainage, on north-facing slopes, or on upland slopes more distant from rivers where permafrost is common.

South-central Alaska is a transition zone between the coastal marine climate of southeast and the continental climate of the interior. These forest communities are more similar to those in the interior, except where Sitka spruce and white spruce ranges overlap and the Lutz spruce hybrid is common. Fire has been a factor in the forest landscape patterns we see today. These fires, however, were mostly the result of human activity; lightning strikes are uncommon in the Cook Inlet area. Major disturbances affecting these forests in the past century have been human activity and spruce beetle caused mortality. Earthquakes, volcanic eruptions, and flooding following storm events have also left significant signatures on the landscape.

Disturbances play an important role in shaping forest composition, structure, and development. With knowledge of disturbance regimes, managers can understand key processes driving forest dynamics and gain insight into the resiliency (the ability to recover) and resistance (the ability to withstand change) of forests to future disturbance. As we improve our understanding of the complexities of these relationships, we are better able to anticipate and respond to natural disturbances and mimic the desirable effects with management activities. Ecological classification is one tool available to help us understand disturbance patterns.

Several useful systems of classification have been developed for Alaska's ecosystems and vegetation. On-going efforts to refine and standardize these classifications across all ownership's will promote effective ecosystem management. ECOMAP (1993) is one system of ecological classification that the Forest Service has adopted and continues to develop. Within this hierarchical system, ecosystems are delineated at multiple scales using different sets of environmental factors. The levels established at this time include Domains, Divisions, Provinces and Sections. Domains represent sub-continental climatic zones. Divisions and Provinces represent climatic sub-zones as reflected by dominant life forms (meadows vs. forests) and broad vegetation types, respectively. Geomorphic and topographic features distinguish sections. The Section level is the first level of the hierarchy where analysis of insect and disease activity becomes applicable.

Throughout this report, we make reference to the Ecosystem Sections of Alaska (see the following page). This map was developed for the Alaska Region (Nowacki and Brock 1995). Section descriptions are included in Appendix D with a list of typical damaging agents. Only Sections where forest cover occurs are described. As the ecological hierarchy classification and mapping are developed to finer scales, they become more valuable as management tools to predict the impacts of various disturbances on forest resources.

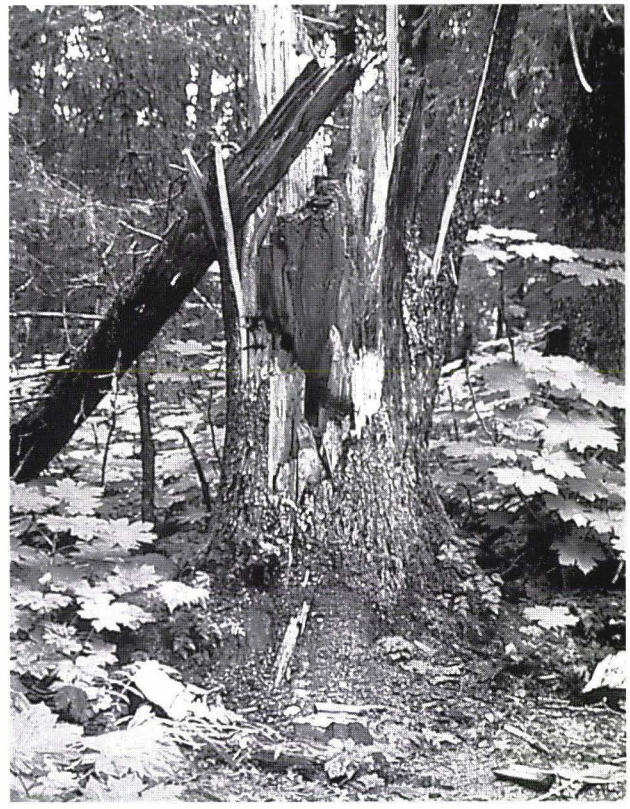
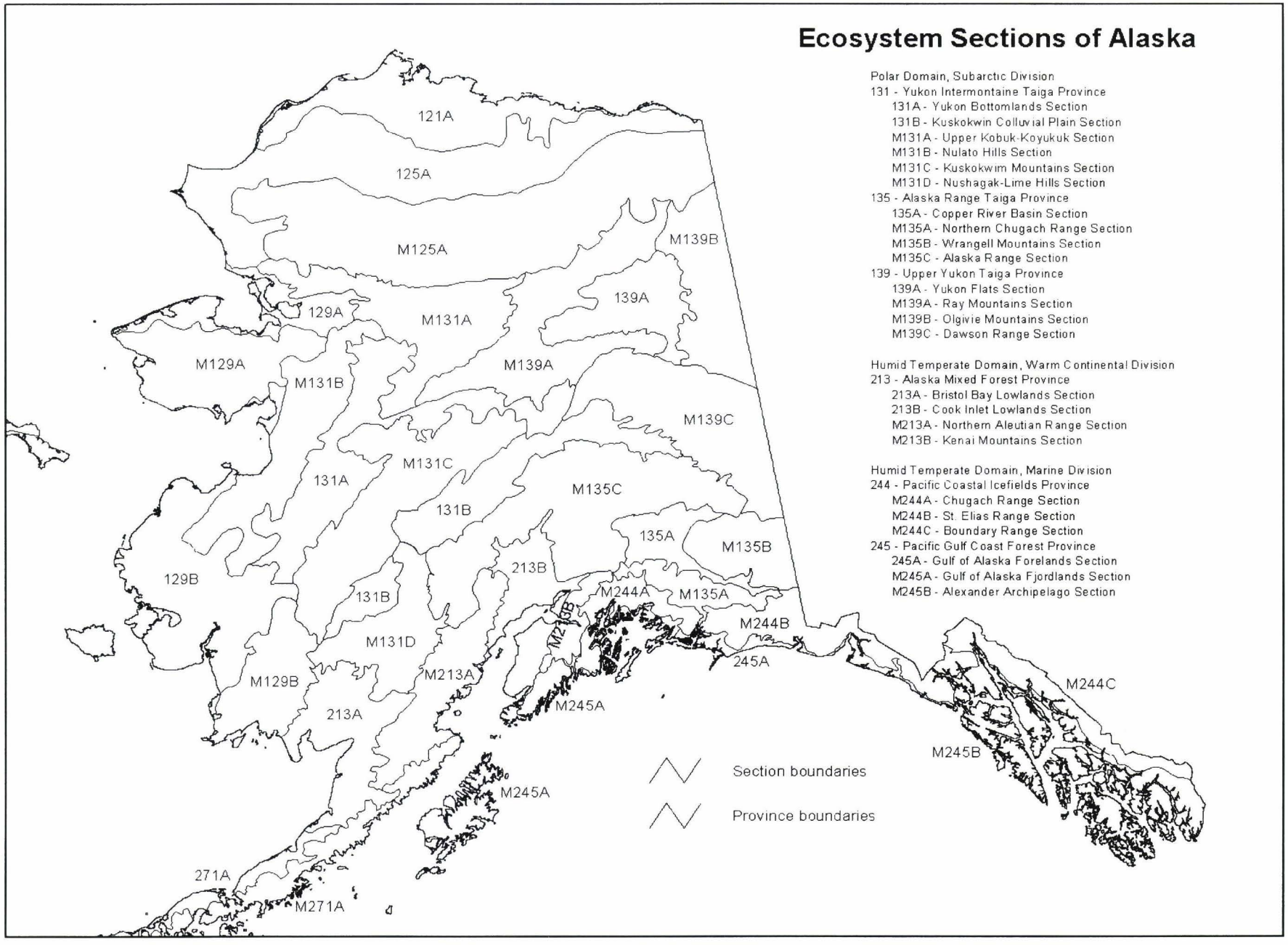


Figure 2. In the temperate rainforests of southeast Alaska frequent small scale canopy gaps are a primary form of disturbance. Heart rot fungi weakened the structural support of trees, which can lead to bole breakage.


Ecosystem Sections of Alaska
Polar Domain, Subarctic Division
131 - Yukon Intermontaine Taiga Province
131A - Yukon Bottomlands Section
131B - Kuskokwin Colluvial Plain Section
M131A - Upper Kobuk-Koyukuk Section
M131B - Nulato Hills Section
M131C - Kuskokwim Mountains Section
M131D - Nushagak-Lime Hills Section
135 - Alaska Range Taiga Province
135A - Copper River Basin Section
M135A - Northern Chugach Range Section
M135B - Wrangell Mountains Section
M135C - Alaska Range Section
139 - Upper Yukon Taiga Province
139A - Yukon Flats Section
M139A - Ray Mountains Section
M139B - Olgivie Mountains Section
M139C - Dawson Range Section
Humid Temperate Domain, Warm Continental Division
213 - Alaska Mixed Forest Province
213A - Bristol Bay Lowlands Section
213B - Cook Inlet Lowlands Section
M213A - Northern Aleutian Range Section
M213B - Kenai Mountains Section
Humid Temperate Domain, Marine Division
244 - Pacific Coastal Icefields Province
M244A - Chugach Range Section
M244B - St. Elias Range Section
M244C - Boundary Range Section
245 - Pacific Gulf Coast Forest Province
245A - Gulf of Alaska Forelands Section
M245A - Gulf of Alaska Fjordlands Section
M245B - Alexander Archipelago Section
121A
125A
M125A
M139B
139A
129A
M131A
M129A
M131B
M139A
M139C
M131C
131A
M135C
131B
135A
M135B
213B
129B
M244A
M135A
131B
M213B
M244B
M131D
245A
M213A
M244C
M129B
M245A
213A
M245B
M245A
Section boundaries
Province boundaries
271A
M271A

STATUS OF INSECTS

INSECTS AS AGENTS OF DISTURBANCE

Insects are active and significant components of Alaska's ecosystems. Arctic/boreal insects are characterized by having few species and large population numbers. Boreal insects are opportunistic in their behavior. They respond quickly to changes in climate and the availability of food and breeding material. The spruce beetle, for example, responds quickly to large-scale blowdown, fire-scorched trees, and spruce injured by flooding. Large numbers of beetles can be produced in such breeding material, leading to potential outbreaks.

Spruce beetles are one of the most important disturbance agents in mature white spruce stands in south-central and interior Alaska. A variety of changes occur to forest resources when many trees are killed. In the long run these changes are biological or ecological in nature. There are also socio-economic consequences in the short-term that can be viewed as either positive or negative, depending on the forest resource in question. Some of the impacts associated with spruce beetle infestations include, but are not limited to:

1. Loss of merchantable value of killed trees: The value of spruce as saw timber is reduced within three years of attack in south-central Alaska due to weather checking and sap-rots. The value of a beetle killed trees as house logs, chips, or firewood continues for many years if the beetle-killed tree remains standing.

2. Long term stand conversion: The best regeneration of white and Lutz spruce and birch occurs on a seedbed of bare mineral soil with some organic material. Site disturbances such as fire, windthrow, flooding, or ground scarification provide excellent sites for germination and establishment of seedlings if there is an adequate seed source. However, on some sites in south-central Alaska, grass and other competing vegetation quickly invade the sites where spruce beetles have "opened up" the canopy. This delays re-establishment of tree species. Regeneration requirements for Sitka spruce are less exacting; regeneration is thus, less problematic.

3. Impacts to wildlife habitat: Wildlife populations, which depend on live, mature spruce stands for habitat requirements may decline. We expect to see decreases in red squirrels, spruce grouse, Townsend Warblers, and possibly Marbled Murrelet populations. On the other hand, wildlife species (moose, small mammals and their predators, etc.) that benefit from early successional vegetation such as willow and aspen may increase as stand composition changes.

4. Impacts to scenic quality: Scenic beauty is an important forest resource. It has been demonstrated that there is a significant decline in public perception of scenic quality where spruce beetle impacted stands adjoin corridors such as National Scenic Byways. Maintaining or enhancing scenic quality necessitates minimizing impacts from spruce beetle infestations. Surveys have also shown that the public is evenly divided as to whether spruce beetle outbreaks damage scenic quality in backcountry areas.

5. Fire hazard: There is concern that fire hazard in spruce beetle impacted stands will increase over time. After a spruce beetle outbreak, grass or other fine vegetation increases; fire spreads rapidly through these vegetation types. As the dead trees break or blow down (5-10 years after an outbreak), large woody debris begins to accumulate on the forest floor. This material (boles) is the largest component of the fuels complex. Heavy fuels do not readily ignite, but once ignited they burn at higher temperatures for a longer period. The combination of fine, flashy fuels and abundant large woody debris results in a dangerous fire behavior situation. Rate of fire spread may increase as well as burn intensity. Observations from recent fires on the Kenai Peninsula have shown an increase in crown fires. This fire behavior is caused by fire traveling up the dead spruce trees and spotting into the crowns of adjacent beetle killed trees.

6. Impact to fisheries: If salmon spawning streams are bordered by large diameter spruce and these trees are subsequently killed by spruce beetles, there is a concern as to the future availability of large woody debris in the streams. Large woody debris in spawning streams is a necessary component for spawning habitat integrity.

7. Impact to watersheds: Intense bark beetle outbreaks can kill large amounts of forest vegetation. The "removal" of significant portions of the forest will impact to some degree the dynamics of stream flow, timing of peak flow, etc. There have been no hydrologic studies in Alaska quantifying or qualifying impacts associated with spruce beetle outbreaks. Impact studies, however, have been done elsewhere. In Idaho watersheds impacted by the Mountain Pine Beetle, there was a 15% increase in annual water yield, a 2-3 week advance in snowmelt, and a 10-15% increase in low flows.

There are a variety of techniques that can be used to prevent, mitigate, or reduce impacts associated with spruce beetle infestations. However, before pest management options can be developed, the resource objective(s) for a particular stand, watershed, landscape, etc. must be determined. The forest manager must evaluate the resource values and economics of management actions for each stand in light of management objectives. The beetle population level must also be considered because population levels will determine the priority of management actions and the type of strategy to be invoked. The key to forest ecosystem management is to manage vegetation patterns in order to maintain species diversity, both plant and animal, while providing for a multitude of resources such as recreation, fisheries, wildlife, and the production of wood fiber. Properly applied silvicultural practices as well as fire management in south-central and interior Alaska, can maintain the forest diversity needed to provide the range of products and amenities available in the natural forest for now and in the future.

BARK BEETLES

Spruce Beetle

Dendroctonus rufipennis Kirby

Since 1996, when total area impacted by spruce beetles peaked at 1.1 million acres, populations have fallen by 77%. This is the lowest figure in the past 10 years. Only 253,265 acres of on-going and new spruce beetle infestations were noted in 1999.

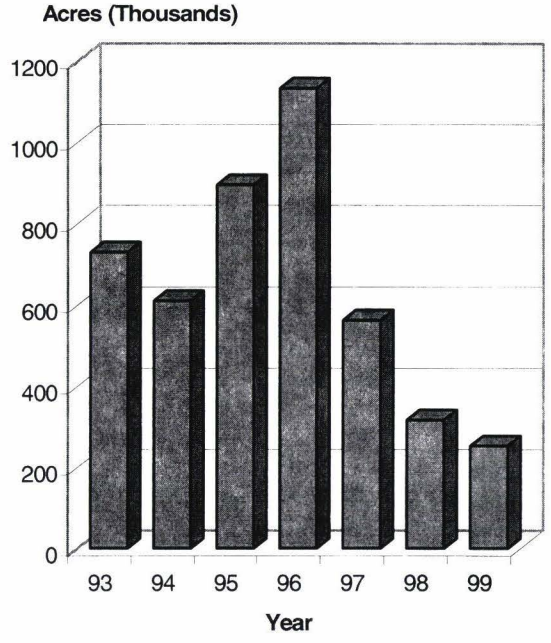


Figure 3. Acres of ongoing and new spruce beetle infestations in Alaska, 1993-1999.

Despite this overall decline, there remain spots of heavy activity, increasing populations and movement into areas as yet undisturbed by the beetle. Continued, smaller-scale activity also persists in areas where suitable host material remains or where new areas of disturbance present beetles with the opportunity for population increases.

Many previous areas of active beetle infestation have been reduced over time to levels considered endemic, as essentially all available host material have been killed. For example, in the majority of the Copper River Valley (135A), Iliamna Lake (M213A), the northern portion of the Kenai Peninsula (M213B), the eastern end of Kachemak Bay and the Anchorage Hillside (213B), the severity of the infestation has declined significantly. Overall, active acreage on the Chugach National Forest has declined by over 50% for the second year and this trend is expected to continue.

Activity continues on the Chugach National Forest, however, in the vicinity of Trail Lakes, Granite Creek and along the Six-Mile River, while just off the Forest, light to moderate infestations were noted in the valleys of Bird and Indian Creek and in the Ship Creek Valley (all in M213B).

The beetle activity on the northern portion of the Kenai Peninsula remains static, but activity is still observed on the lower Peninsula particularly in a band 1-3 miles wide along the eastern shore of Cook Inlet from Happy Valley to Homer (213B). On the south side of Kachemak Bay, beetles remain quite active between Tutka Bay and Seldovia (M245A). The activity is most intense in the Tutka Bay area, gradually lessening in intensity while moving west toward Seldovia. Activity along the eastern portion of the Bay including Bradley Lake and the Fox River Valley has returned to endemic levels (M244A).

The Susitna valley (213B) remains fairly static in numbers of affected acres. Though the total area affected has risen slightly since last year, the infestation falls within what would be considered endemic levels. This is characteristic of a beetle population progressing in mixed forest-types heavily populated by birch and aspen with a mosaic of age classes. Much of the activity is located along the Susitna River where river bank erosion provides the beetle with fresh opportunities for locating brood material in the form of fallen, large-diameter, green trees.

In the Copper River Valley (135A) spruce beetle activity is now occurring in a narrow band along the Copper River running from Copper Center to Chitina. Much of this activity falls in the "light to moderate" category.

Further south, along the Bremner and Tana Rivers (M135A), intense beetle activity continues with many of the stands totally infested. Activity is quite heavy; nearly 100% of the spruce in these areas are infested. Continuation of this infestation, especially at these severe levels, is in doubt due to depletion of the spruce resource.

Much of the activity in the immediate area of McCarthy has fallen to endemic levels. Some small-scale activity persists, but is characterized as "light" activity. Some light activity persists as well along the Chitina River between the Tebay River and the confluence of the Tana and Nizina Rivers. This activity has been in progress for several years and will probably persist at these levels for several years as many susceptible stands of spruce remain. The area of most intense beetle activity was observed along the Hanagita River (M135A), where more than 22,000 acres of intense activity were mapped. It appears this infestation may have been in progress for at least one to two years, but has not been flown until 1999. This drainage, as well as nearby, associated valleys, will be evaluated again during aerial surveys in the summer of 2000.

In the Lake Clark area, beetle activity remains quite high along the Tlikakila River (M213A) where nearly 13,000 acres of active infestations were observed. This outbreak has persisted for several years and most of these susceptible stands have already been heavily impacted. The outbreak should ending, unless it spills over into Lake Clark National Park. Thus far, movement westward into the Park has been unsuccessful. Although vast areas of contiguous spruce forest exist just west of the intense activity in the Lake Clark Pass area, for reasons little understood, the beetle has been unable to exploit this large, untouched resource.

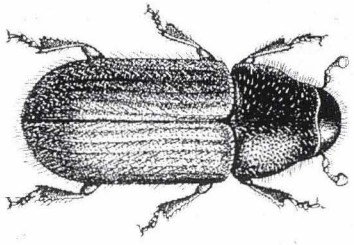


Figure 4. ***Dendroctonus rufipennis.***

The final area of active infestations is located on the west shore of Cook Inlet (213B), specifically between the McArthur and Beluga Rivers. This includes the area of the West Forelands where activity persists, but it has lessened in severity due to the dwindling host type. The infestations located in the vicinity of Big River Lakes and the entrance to Lake Clark Pass has essentially run its course, killing a majority of the host type. Scattered areas of activity are still present throughout the entire area, but add little to the overall impact. One new area of activity was mapped near Little Mt. Susitna and warrants watching during the next few flight seasons.

Scattered activity persists along the Kuskokwim River primarily downstream from McGrath and along the Big River (M131C). This activity has persisted for a number of years, but has not expanded to levels that would generate concern. Small-scale logging operations downriver from McGrath continue to operate in the midst of these areas impacted by the

beetle. 1,816 acres of beetle activity were noted this year near Sleetmute possibly as a result of the stress placed on these stands by flooding in the past few years. Recent wildfires in this area may have mitigated some of this problem.

Other new areas of beetle activity are Nabesna (M135B), Lime Hills (M131D), Russian Mission (129B) and Candle (M129A). These areas will continue to be monitored as time and resources allow. Rapid development of these small outbreaks is not occurring do to forest type and environmental conditions.

Figure 5. Bark beetle gallery patterns

Spruce beetle activity in southeast Alaska's Sitka spruce forests declined about 82% to 6,556 acres in 1999 from 1996 infested acres. Sixty-six percent of these acres were on the Tongass National Forest. Fifty-nine percent of these acres were in the driest precipitation zone (zone 1, 0-60 inches per year) of the Chilkat and Chilkoot River basins (***Figure 6***). Twenty-four percent of these acres were in the next driest zone (zone 2, 61-92 inches per year) (Lynn Canal, Glacier Bay National Park, upper Taku River and lower Stikine River, most of Admiralty Island, east side of Zarembo Island, east side of Mitkof Island, west and south side of Etolin Island). Fifteen percent of these acres were in the next to the wettest zone (zone 3, 93-150 inches per year) (Yakutat Forelands and south along the coast to Dundas Bay, most of Chichagof Island, the south end of Kuiu Island, south and east half of Kupreanof Island, most of Prince of Wales island, Behm Canal, and south of Smeaton Bay to Portland Canal). Only two percent of these acres were in the wettest zone (zone 4, 151-300 inches per year) (upland areas, east side of Baranof Island, south end of Kuiu Island, east side of Dall Island, and the south end of Prince of Wales Island).

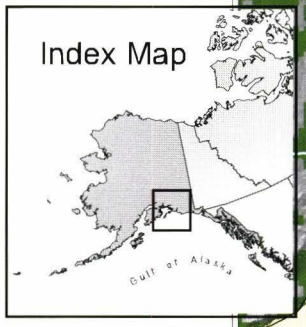
Engravers

Ips perturbatus Eichh.

In one year (1999), engraver activity declined by 59% from 9,290 acres to 3,778. Oftentimes, it is difficult to delineate the causal agent of spruce mortality within a beetle outbreak from the air. In some situations, *Ips* beetle may be active alongside spruce beetle. Therefore, what may be identified as spruce beetle mortality from aerial survey data may be *Ips* activity, or even a combination of the two beetles working in consort. Frequently, *Ips* populations will build quickly in the tops of spruce trees infested by spruce beetle. In areas of large-scale spruce beetle activity, great quantities of brood host material are provided for *Ips* in the form of the tops of these stressed trees. On the Kenai Peninsula, it has been noted particularly in cut-over areas, that *Ips* beetles tend to build in numbers when shaded slash greater than 4 inches in diameter has been left on the ground following logging activity. If enough suitable brood material remains, *Ips* numbers can increase to levels large enough to infest standing, healthy trees. This has been the case with *Ips perturbatus*, a particularly aggressive species of *Ips*. The subsequent population build-up of this species can have a significant negative impact on the survival of residual trees within the stand.

Ips beetle activity in interior Alaska is most often associated with disturbances such as riverbank erosion, top breakage, logging, or wind. Along many of the interior rivers, riverbank erosion is the precipitating event for small-scale outbreaks and much of the endemic activity. Such has been the case for much of the activity in the upper Yukon River (131A) valley and its associated drainages for the past several years. During 1999 aerial surveys, all recent, small-scale outbreaks, such as those on the Christian and Sheenjek Rivers (M139A), have declined to endemic levels.

Copper River Spruce Beetle Impact



Current Spruce Beetle Infestation
Old Spruce Beetle Infestation
Forested
Non-Forested
Snow and Ice
Water

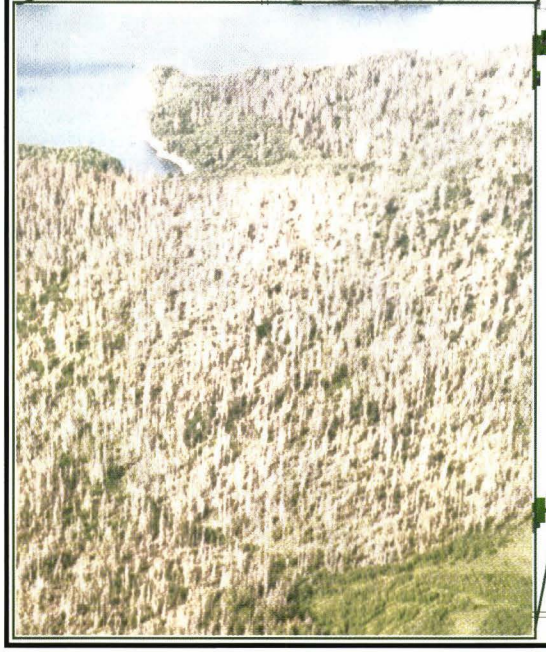
Copper Center
Chitina
McCarthy
Valdez
Cordova

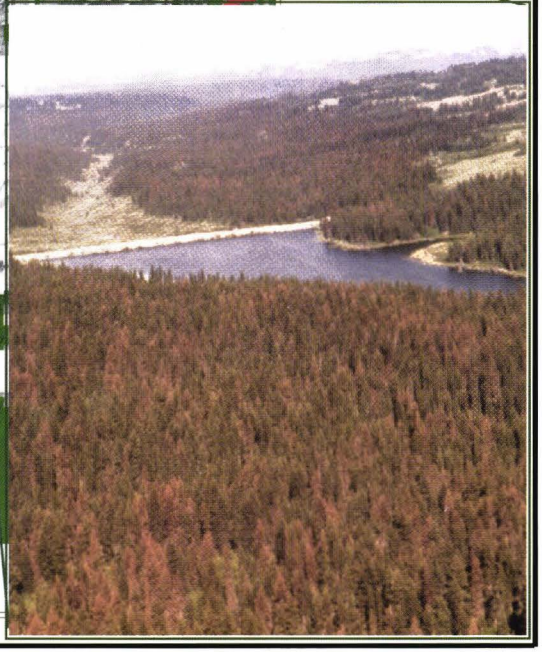
N

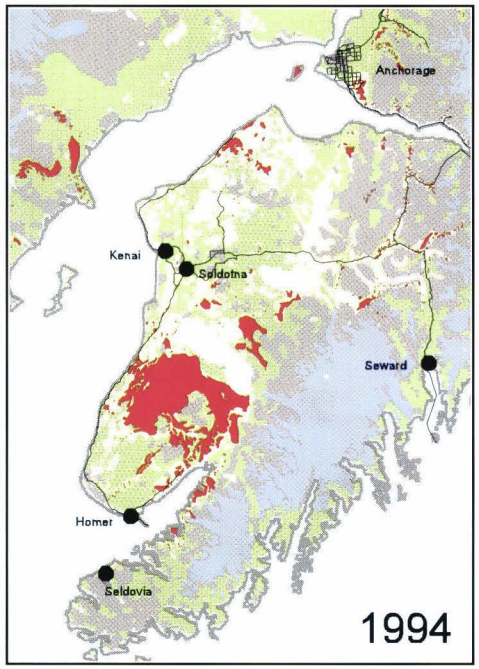
USDA Forest Service
Forest Health Protection
Date Printed: 1 12 2000

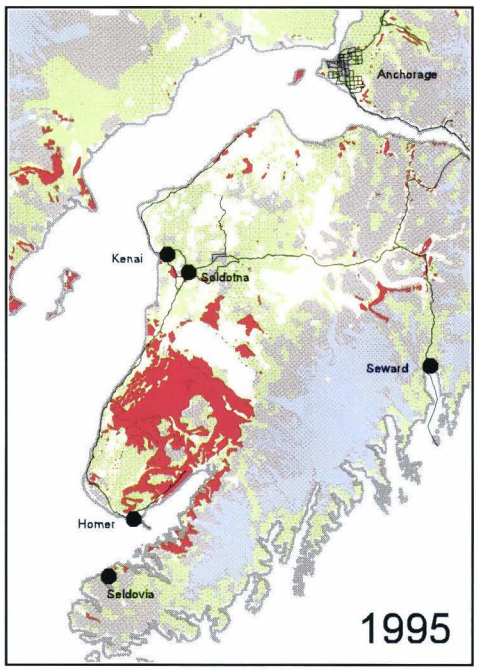
25 0 25 50 Miles

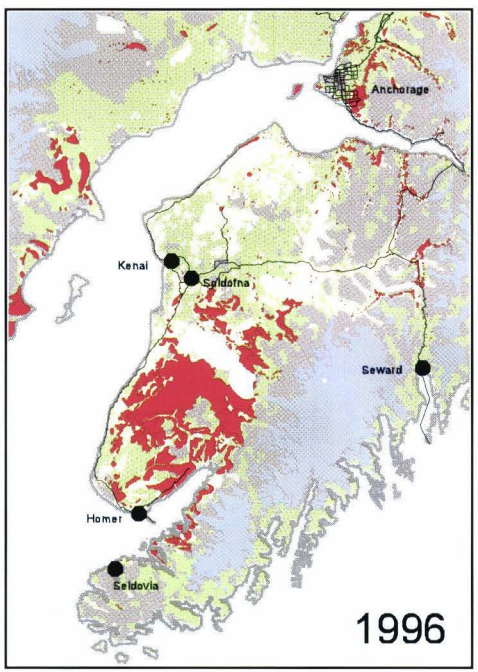
Sources:
1999 Spruce Beetle damage from I&D Aerial Survey, USFS FHP & ADNR.
Cumulative Spruce Beetle damage from 1989 - 1998 I&D Aerial Survey, USFS FHP & ADNR.
Landcover from a 23 class vegitation layer, UC Berkeley/ Integrative Biology and U.S. Geological Survey/Alaska Field Office.

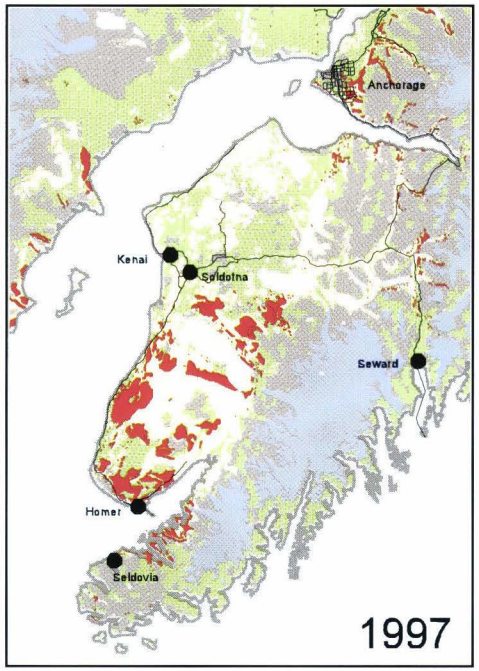


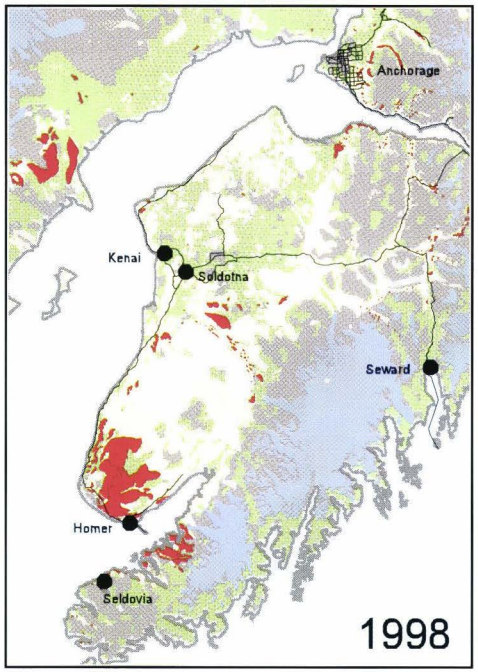


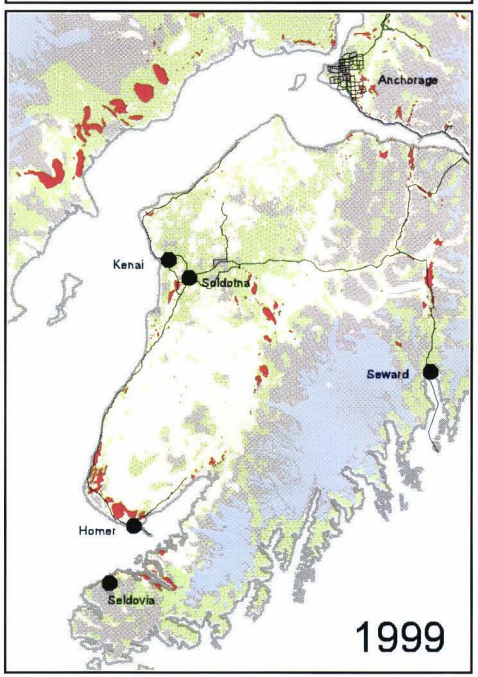










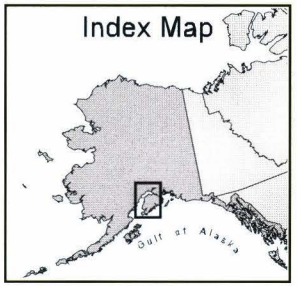


Spruce Beetle Activity Kenai Peninsula 1994-1999

- Spruce Beetle Mortality
- Prior SPB Mortality
- Forest
- Non-Forest
- Glacier

10 0 10 20 30 40 50 Miles

Index Map



Sources:
1999 Spruce Beetle damage from I&D Aerial Survey, USFS FHP & ADNR.
Cumulative Spruce Beetle damage from 1989 - 1998 I&D Aerial Survey, USFS FHP & ADNR.
Cumulative Spruce Beetle damage from 1972 - 1990 Aerial Survey, USFS/ISER.
1998 Map - "Spruce Beetle Activity Kenai Peninsula 1993 - 1998", ADNR/USFS

USDA Forest Service
Forest Health Protection
Date Printed: 1/12/2000

DEFOLIATORS

Fewer defoliator plots (27 plots) were visited during the 1999 aerial survey than in previous years (52 plots) throughout southeast Alaska. An effort was made to distribute these plots evenly across the archipelago.

The objectives during the 1999 season were to:

- Spend more time covering the landscape during the aerial survey,
- Allow more time to land and identify unknown mortality and defoliation, and
- Avoid visit sites that were hard to get to and had few western hemlocks.

Hemlock sawfly and black-headed budworm larvae counts were generally low in 1999 as they were in 1998. The highest sawfly larvae counts were from the plots in Thorne Bay and Kendrick Bay, Prince of Wales Island. Larval counts are used as a predictive tool for outbreaks of defoliators. For example, if the larval sample is substantially greater in 1999, then an outbreak would be expected in 2000.

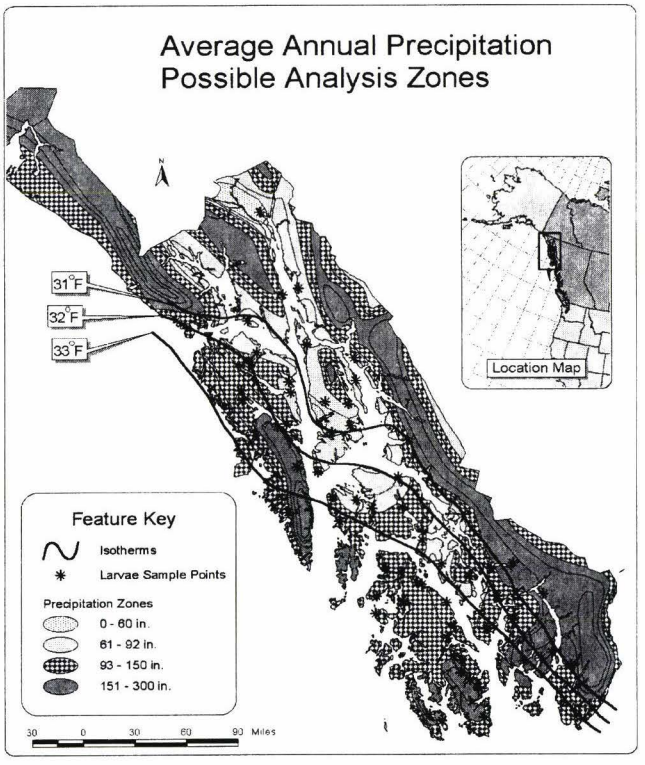


Figure 6. The above map displays mean annual precipitation for southeast Alaska, 1941-70, with winter isotherm and defoliator larvae sampling plots. The above classification will be used in an attempt to spatially analyze insect activity throughout southeast Alaska. Reference is made to this map in selected insect sections. ***(Precipitation information from Schwartz, F.K., and Miller, J.F. 1983. Probable maximum precipitation and snowmelt criteria for southeast Alaska: National Weather Service Hydrometeorological Report No. 54. 115p. GIS layer created by: Tim Brabets, 1997.*** *URL:http://agdc.usgs.gov/data/usgs/water)*

Spruce Needle Aphid

Elatobium abietinum Walker

Spruce needle aphids feed on older needles of Sitka spruce, often causing significant amounts of needle drop (defoliation). Defoliation by aphids cause reduced tree growth and can predispose the host to other mortality agents, such as the spruce beetle. Severe cases of defoliation alone may result in tree mortality. Spruce in urban settings and along marine shorelines are most seriously impacted. Spruce aphids feed primarily in the lower, innermost portions of tree crowns, but may impact entire crowns during outbreaks. Outbreaks in southeast Alaska are usually preceded by mild winters.

Following the mild winter of 1991-92, spruce needle aphid populations expanded rapidly in southeast Alaska, causing over 25,000 acres of Sitka spruce defoliation. Populations crashed in 1993 due to extended periods of sub-freezing temperatures during January and February. After a slight resurgence of activity in 1994, the 1995 population levels were low. Another outbreak occurred in 1998 following another mild winter, resulting in 46,300 acres of defoliation. Southeast Alaska accounted for 44,300 acres with 39,100 of those acres on national forest lands.

In 1999, just over 4,000 acres of defoliation were detected, a 91% reduction from 1998 acres. Only 2800 acres were defoliated on the Tongass National Forest compared to 39,100 acres in 1998, a 93% decline in acres. Much (76%) of the 1999 acres were in the warmest winter zone (≥ 33°F for the average temperature of December, January, and February combined [Anderson 1955])(***Figure 6***). Twenty percent and 4% were in the ≥32°F to <33°F and ≥31° to <32°F temperature zones, respectively. Most (96%) of the total acres were in precipitation zone 3, and the other 4% were in precipitation zone 2. Climatically, many of the acres aerially detected in 1999 were in the warm-wet zone of Southeast Alaska.

Western Black-Headed Budworm

Acleris gloverana Walsingham

The black-headed budworm is native to the forests of coastal and southwestern Alaska. It occurs primarily in southeast Alaska and has been documented there since the early 1900's. Budworm populations in Alaska have been cyclic, arising quickly, impacting vast areas, and then subsiding within a few years.

In southeast Alaska, a peak year for budworm defoliation occurred in 1993, totaling 258,000 acres. The last budworm outbreak of this magnitude occurred from the late 1940's to mid-1950's. Cool-wet weather in early summer months retards the growth and development of the budworm and may have resulted in population declines. Black-headed budworm populations crashed in 1995. In 1998 and 1999 no budworm defoliation was aerially detected.

Due to adverse flying conditions, we were unable to examine forest health conditions in Prince William Sound (M244A, M245A) in 1999. In 1996 and 1997, approximately 30,000 acres of defoliation were observed. However, reports from ground personnel indicate that the recent outbreak of the western black-headed budworm has substantially declined. This is most likely due to the cool, wet weather the Sound experienced this spring. Inclement weather is often a major limiting factor in budworm outbreaks. We expect to survey this area in 2000.

Figure 7. Progression of top-kill following repeated defoliation.

Hemlock Sawfly

Neodiprion tsugae Middleton

Hemlock sawfly, a common defoliator of western hemlock, is found throughout southeast Alaska. Historically, sawfly outbreaks in southeast Alaska have been larger and of longer duration in areas south of Frederick Sound (M245B). In 1999, sawfly defoliation was virtually nonexistent, this coming after a 59% decrease in 1998 from 1997 levels when 2,500 acres were recorded.

Of the 89 acres of hemlock sawfly defoliation detected in 1999, 64% of the acres were in warmest winter temperature zone while 36% were in the ≥32°F to <33°F zone. Twenty percent of the acres were in precipitation zone 3, 80% were in wettest precipitation zone 4. Climatically, many of the acres were in the warm-wet zone of southeast Alaska. ***Figure 6*** illustrates the above referenced climatic zones.

Unlike the larvae of the black-headed budworm, hemlock sawfly larvae feed in groups, primarily on older hemlock foliage. These two defoliators, feeding in combination, have the potential to completely defoliate western hemlock. Heavy defoliation of hemlock by sawflies is known to cause reduced radial growth and top-kill. Hemlock sawflies may ultimately influence both stand composition and structure in some areas. The sawflies themselves are a food source for numerous birds, other insects, and small mammals.

Spruce Budworm and Coneworm

Choristoneura fumiferana (Clemens)
Choristoneura orae (Freeman)
Dioryctria reniculelloides Mutuura & Munroe

Acres of defoliation attributed to the eastern spruce budworm and coneworm significantly decreased in 1999. Only 708 acres of light to moderately defoliated spruce were noted in 1999 vs. 87,800 acres noted in 1998. This budworm/coneworm defoliation occurred along the Yukon River from Ruby to Weir Island (131A). It appears that after more than five consecutive years, the budworm/coneworm outbreak has declined probably due to the increasing affects of parasites and predators. We expect little defoliation next year. A ground survey, conducted in late summer of 1999 by Tanana Chief Council crews, noted no mortality associated with the budworm/coneworm outbreak, although top-kill was prevalent. Little *Ips* spp. activity was noted in previously defoliated spruce stands.

Larch Sawfly

Pristiphora erichsonii (Hartig)

Total acres of land affected by the larch sawfly in 1999 were 189,576 acres; a significant reduction from the more than 450,000 acres of defoliated larch observed in 1998.

The area of most intense activity remains the vast area between McGrath and the Alaska Range (131B). After seven years of heavy defoliation, larch mortality is occurring. The concern still exists that larch beetle may begin to build up in these heavily defoliated stands which could result in further mortality. Virtually every ecosection in interior Alaska where larch occurs is experiencing larch sawfly activity. The Alaska Cooperative Extension Integrated Pest Management Technicians noted localized defoliation of Siberian larch in the Mat-Su Valley and Anchorage Bowl. This is the first time the sawfly has been recorded south of the Alaska Range and no doubt represents an accidental introduction. Efforts are being undertaken to eradicate this pest from these areas as Siberian larch is widely used as an ornamental in urban settings.

Figure 8. Larch sawfly larvae

Birch Defoliation

Fenusa pusilla (Lepeletier)
Euceraphis betulae (Koch.)

For the third consecutive year, birch defoliation was very noticeable in the Anchorage Bowl (213B). Birch aphids (*E. betulae*) were more noticeable early in the season. In late July and August, the Birch miner (*F. pusilla*) was responsible for additional defoliation. Although the hardwoods have been defoliated for several consecutive years, as yet there doesn't appear to be any lasting damage.

Large populations of birch aphid are responsible for honeydew, leaf-curling, and browning. Birch aphids are small and greenish-brown; they may be winged or wingless. Aphids usually over-winter as eggs, hatch in the spring as females that can reproduce without mating, and give birth to live young. Aphids are very responsive to changes in temperature. During warm dry summers, enormous aphid populations can develop in a relatively short time. Even so, aphid damage to Alaska birch forests is negligible.

The birch leafminer was first reported in eastern United States in 1923. Introduced from Europe, it has spread rapidly throughout the northern United States, Canada, and Alaska. The adult sawfly is black, about 3 mm long, and similar in appearance to a common fly. Larvae overwinter in cocoons in the soil and adults appear in the spring when the first birch leaves are half grown. The female sawfly deposits her eggs singly on newly developing leaves. At times, almost every leaf is mined by the developing larvae, giving it a brown color. When mature, the larva cuts a hole through the leaf and drops it to the ground. There the larvae build a cell in which pupation takes place; 2-3 weeks are usually required for transformation into the adult stage. A re-flushing of leaves may occur, and a second generation of egg-laying sawflies may develop. Two to four generations of this insect can develop in northeastern US; the number of generations in Alaska is not known.

Large Aspen Tortrix

Choristoneura conflictana Wlkr.

Acres of aspen affected by tortrix populations throughout Alaska declined in 1999 by 41% to only 13,336 acres. This decline is consistent with the cyclic nature of these insects. The outbreaks were located almost exclusively in interior Alaska with the exception of one area of small-scale, but persistent activity located near Skilak Lake on the Kenai Peninsula (213B). A large decline was noted in this population as well, falling from over 14,000 acres in 1998 to only 578 acres in 1999.

The most active areas were found to be near Fairbanks along the Tanana (131A), Nenana and Kantishna Rivers (131B), along the Yukon River between Henry and Weir Islands (M139A), approximately 50 miles downriver from Tanana and on the Hoholitna River (131B) about 30 miles southeast of Sleetmute. Smaller, yet quite active populations were located near Nabesna and on the Innoko River near Ophir (131A).

Historically, populations of tortrix tend to cycle over time in response to environmental conditions. A pattern of one to two years of increasing activity followed by two to three years of decline remains fairly consistent. Weather, starvation and parasites are the most important factors in precipitating these declines. In severe infestations, complete stripping of aspen foliage before the last instar larvae develop will reduce populations due to widespread starvation. In terms of acres affected by tortrix populations, the disparity between epidemic and endemic populations can be quite dramatic. Statewide, from 1966-1969, nearly 6,000,000 acres of active infestations were observed, while in 1985, only 2,000 acres were noted. Thus, it is quite difficult to make predictions about the future course of action of these highly variable populations of insects.

Gypsy Moth

Lymantria dispar (L.)

The European gypsy moth was accidentally introduced into the eastern U.S. in the late 1800's. Since then, the gypsy moth has been responsible for considerable damage to the hardwood forests of the east. The gypsy moth has been also introduced to the western U.S. where millions of dollars have been spent on its eradication.

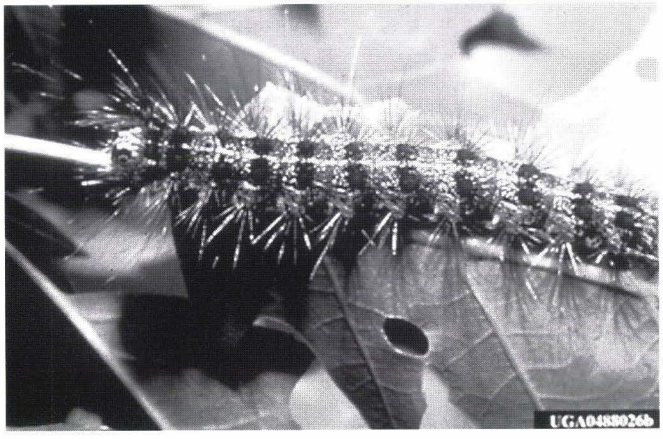


Figure 9. Gypsy moth larvae

Since 1986, Forest Health Protection, in conjunction with Alaska Cooperative Extension and USDA APHIS, has placed gypsy moth pheromone monitoring traps throughout Alaska. To date, only two European gypsy moths have been trapped in Alaska. As far as we know, populations of the gypsy moth have not been established in Alaska. Due to the detection of the Asian gypsy moth (a more damaging race of the European gypsy moth) in the Pacific Northwest, more than 200 detection traps were placed throughout Alaska in 1999. No Asian or European gypsy moths were collected. If the Asian gypsy moth becomes established in the western U.S., including Alaska, the potential impacts to forest and riparian areas could be tremendous. The trapping program will be continued next year.

Cottonwood Leaf Beetle

Chrysomela spp.

Moderate cottonwood defoliation was noted throughout interior Alaska by the cottonwood leaf beetle. The beetles were once again observed in localized areas throughout the Anchorage Bowl (213B). Forest Health Protection staff and Alaska Cooperative Extension personnel received numerous calls from concerned citizens regarding the defoliation and the larvae. The feeding larvae are black, segmented grubs with two rows of white dots along their back. Larvae skeletonize the leaves by feeding on the surface of the leaf, resulting in a scorched appearance. The adult beetles are black with orange markings and are often mistaken for large ladybug beetles. Adults overwinter in leaf litter. Removal of leaf litter can help to reduce beetle numbers.

Willow Leaf Blotchminer

Micrurapteryx salicifolliela (Chambers)

The outbreak of the willow leaf blotchminer rose dramatically again in 1999. This year, defoliation rose to 180,396 acres vs. 123,070 acres noted in 1998. As in the past, the majority of the blotchminer activity is located in the upper Yukon River Flats area (139A) and the rivers that drain into the Yukon throughout this region (131A, B, M139A, B, C, and M129A). The infestation of the blotchminer probably covers many more acres than actually observed. Oftentimes, the brown-appearing, defoliated willow stretches as far as one can see from the air; however, cost prohibits more thorough coverage. Some willow mortality has been observed and the concern remains that widespread mortality may have a detrimental effect on availability of willow sprouts, upon which moose depend heavily as a food source.

This insect was not known in Alaska previously. There is one generation per year with the pupal stage as the overwintering stage. Ten species of willows have been observed infested, the severity of which differed somewhat between localities and species. Feltleaf willow, *Salix alaxensis*, is not infested due to its under leaf surface being covered by a protective felt-like mat of hairs that prevents attachment of blotchminer eggs.

Alder Woolly Sawfly

Eriocampa ovata (L.)

Moderate defoliation of Sitka and thinleaf alder was observed for the third consecutive year in many parts of the Anchorage Bowl (213B). Heavy defoliation was also observed throughout southeast Alaska on red alder. This sawfly is a European species now established throughout the northern U.S., Canada, and Alaska. The larvae are covered with a distinctive shiny, woolly secretion. They skeletonize the lower leaves on young alders; the upper crown is usually not fed upon. Populations are expected to decline next year as a result of this summer's cool and wet conditions.

Figure 10. Alder woolly sawfly larvae

Spotted Tussock Moth

Lophocampa maculata (Harris)

Light to moderate defoliation of blueberry (*Vaccinium* sp.) and Sitka alder (*Alnus sinuata*) has been observed during the summer of 1999 from Wrangell Island south to Ketchikan (M245B). The causal agent was determined to be the spotted tussock moth (*Lophocampa maculata* (Harris). The name Spotted comes for the spotted fore wings of the adult (white spots on a buff background). The name Tussock refers to the long tufts of hair that extend beyond the body of the caterpillar. The mid-abdominal segments of the early instar caterpillars have red hairs among bright yellow hairs. The anterior and posterior have long wisps of white hairs with shorter yellow and black hairs. The mid-abdominal segments of the late instar has wisps of long white hairs among reddish-orange hairs; the anterior and posterior is predominantly black with long wisps of white hairs among short black hairs. They are commonly known elsewhere as woolly bears. The gray cocoon is formed from the long body hairs and silk; they probably overwinter in the leaf litter layer. The adult probably emerges in spring. Different forms of this Lepidopteran live throughout western North America.

MISCELLANEOUS FOREST INSECTS

Hawkmoth

Hyles galii (Rottenburg)

Moderate to heavy defoliation of fireweed (*Epilobium* spp.) and other perennials by hawkmoth larvae has been observed throughout Alaska. The larval body is black with a red head, horn, and eyespots (along body). In addition, the body also has rows of small yellow spots. The adult is a good flyer with a pale band down the middle of the fore-wing and red in the hind-wing. The adults feed on flower nectar and are seen from May to August. Larvae feed on fireweed until late fall then overwinter as a cocoon in the leaf litter. Many people are frightened and delighted by the moth that appears to fly like a bird. This hawkmoth is known as the bedstraw hawkmoth because it feeds on bedstraw (*Galium* spp.). It is found across North America from the east coast to Colorado and California, north to the Canada and Alaska.

Sitka Spruce Weevil

Pissodes strobi Peck

Adult Sitka spruce weevils were collected for the first time in the Anchorage Bowl in 1995 and again in 1996-97. The weevils were collected from infested nursery stock (blue spruce) brought into the state from the Pacific Northwest. Developing larvae, pupae, and callow adults were encountered in 1998 in out-plantings of spruce in west Anchorage; an indication that the spruce weevil may have adequate developmental conditions to become established in south-central Alaska. A follow-up ground check in the west Anchorage area found no new Sitka spruce weevil activity on new out-plantings. All of the infested shoots seen in this area were clipped and disposed of. In 1999, Sitka spruce weevils were found in a State of Alaska, Department of Transportation landscape planting near Tudor Road and "C" St. in Anchorage. The infested terminals were clipped and destroyed. We will continue to monitor the potential

establishment of this serious pest of ornamental and native spruce.

Spider Mites: Acarina

***Paratetranychus* spp. and *Tetracychus* spp.**

The Anchorage IPM Technicians (Alaska Cooperative Extension) noticed extensive damage to spruce trees from spider mite feeding in 1999. This damage was most visible in August and September. Infested trees showed signs of yellowing needles in a "flagging" pattern and green needles appeared dull in color with much webbing present. Some defoliated trees exhibited an overall decline in appearance and then dropped the faded needles. Weeks of warm, dry weather early in the spring may have contributed to the abundance of spider mites.

Figure 11. Webbing is initially apparent with spider mite feeding. Needles will become discolored and fall off.

Figure 12. Fire followed a spruce beetle infestation in the Hidden Lakes area. Fire and insects are key agents in forest disturbance.

Figure 13. Old spruce beetle mortality in a high volume stand of southeast Alaska.

Figure 14. Willow defoliation has been recorded on over180,000 acres throughout the interior of Alaska in 1999.

Figure 15. This year larch sawfly were responsible for nearly 160,000 acres of larch defoliation in Alaska. An adult larch sawfly is pictured above.

Aerial Detection Survey - 1999

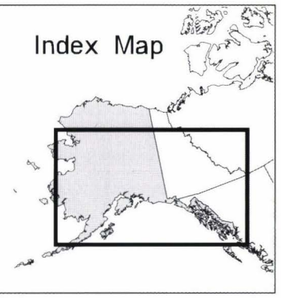
Significant Pest Activity

- Spruce Beetle Mortality
- IPS Mortality
- Larch Beetle Mortality
- Larch Sawfly Defoliation
- Willow Defoliation
- Cedar Decline "Hotspots"

Landcover

- Forest
- Tall Shrub
- Non-Forest
- Snow & Glacier

Index Map



Sources:
1999 Insect & Disease Damage from Insect & Disease Aerial Detection Survey, USFS FHP & ADNR, 1999.
Yellow-Cedar Decline - 1999 hot spots, denotes areas of high intensity with trees in the "red" condition, USFS FHP.
Landcover from a 23 class vegitation layer, UC Berkeley/Integrative Biology and U.S. Geological Survey/Alaska Field Office.
Note:
Many of the most distructive diseases are not represented on this map because these agents are not detectable from aerial surveys.
Disturbance polygons are accented with a large border for visulation.

USDA Forest Service
Forest Health Protection
Date Printed: 1/12/2000

Fort Yukon
Fairbanks
McGrath
Glennallen
Anchorage
Homer
Kodiak
Haines
Juneau
Gulf Of Alaska

50 0 50 100 150 200 Miles

Alaska
Aerial Detection Survey
Flight Paths
1999

Arctic Ocean

Chukchi Sea

Bering Sea

Bristol Bay

Gulf Of Alaska

Flight Paths

National Forest	5,737,000
Other Federal	10,301,000
Alaska Native Corporation	5,281,000
State & Private Lands*	10,027,000
Total Acres Flown	31,346,000

*Includes State Patented, Tentatively Approved or other State Acquired Lands, of Patented Disposed Federal Lands, Municipal or Other Private Parcels.

50 0 50 100 150 200 Miles

Soures:
Flightline data from I&D Aerial Survey, USFS FHP & ADNR, 1999.
Alaska Land Status data from ADNR, LRIS 1998.
1998 Map - "Aerial Detction Survey Flight Paths 1998", ADNR/USFS.

USDA Forest Service
Forest Health Protection
Date Printed: 1/12/2000

Figure 16. Spruce needle rust was found at high levels in 1999.

Figure 17. Yellow-cedar decline occurs on approximately 500,000 acres in Southeast Alaska..

Figure 18. Spruce broom rust affects all species of spruce in Alaska.

Figure 19. This log end displays both hemlock fluting, and a hollow caused by white rot.

STATUS OF DISEASES

ECOLOGICAL ROLES OF FOREST DISEASES

The economic impacts of forest diseases in Alaska have been recognized for some time. In southeast Alaska, heart rot fungi cause substantial cull of nearly 1/3 of the gross volume in old-growth hemlock-spruce forests. Also a high incidence of cull in white spruce, paper birch, and aspen forests in the south-central and interior regions is considered a limitation on the availability and cost of harvesting timber. Traditionally, management goals sought to eliminate or reduce disease to minimal levels in an effort to maximize timber outputs. As forest management goals broaden to include enhancement of multiple resources and retaining structural and biological diversity, forest diseases management can be assessed from an ecological perspective.

Figure 20. Decay fungi play vital roles in recycling nutrients and producing habitat for animals large and small.

We are learning that diseases are key ecological factors in Alaskan ecosystems. They enhance biological diversity, provide wildlife habitat, and alter forest structure, composition, and succession. As agents of disturbance in the western hemlock/Sitka spruce forests of southeast, diseases apparently contribute for the "breaking up" of even-aged stands as they are in transition (i.e., 150 to 200 years old) to old-growth phase. Then, they appear to be among the primary factors that maintain stability in the old-growth phase through small-scale (canopy-gap) level disturbance. Much less is known about the ecological role of diseases in south-central and interior forests, however diseases appear to be agents of small-scale disturbance in all successional stages of spruce and hardwood forests.

Forest practices can be used to alter the incidence of diseases to meet management objectives. Two of the principal types of conifer disease that influence forest structure in Alaska, heart rot and dwarf mistletoe, can apparently be managed to predictable levels. If reducing disease to minimal levels is a management objective, then both heart rot and mistletoe can be largely eliminated through clearcut harvesting and even-aged management. However, to reduce disease to minimal levels in all instances is to diminish the various desirable characteristics of forest structure and ecosystems functions that they influence. Heart rot organisms and dwarf mistletoe provide unique forest structural components that may be lost for decades or perhaps centuries after clearcutting. Research indicates that harvesting practices other than clearcutting can be used to retain structural and biological diversity by manipulating these diseases to desired levels. Since heart rot in coastal stands is associated with natural bole scars and top breakage, levels of heart rot can be manipulated by controlling the incidence of bole wounding and top breakage during stand entries for timber removal. Levels of dwarf mistletoe can be manipulated through the distribution, size, and infection levels of residual trees that remain after harvest. Our ongoing research indicates that the incidence and effects of these diseases will vary through time in a predictable manner by whatever silvicultural strategy is used.

Research is currently underway in south-central and interior Alaska to assess the economic and ecological impacts of root diseases. Root diseases are difficult to detect, remain active on site in trees and stumps for decades, infect multiple age classes, and cause substantial volume loss. Ecologically, root diseases create canopy gaps that contribute to biodiversity, wildlife habitat, and succession. Elimination of root disease from an infected site is challenging because the infected material is primarily located in buried root systems. Establishment of non-host material within root rot centers is an effective option for manipulating levels of root disease. Ongoing research on the relationship between species composition and root disease incidence in south-central and interior Alaska will provide important information for both ecological and forest management considerations.

Table 3. Suspected effects of common diseases on major ecological characteristics and processes in Alaskan forests.

Effects by each disease of disorder are qualified as: - = negligible or minor effect, + = some effect, ++ = dominant effect.

	ECOLOGICAL FUNCTION ALTERED			
DISEASE	STRUCTURE	COMPOSITION	SUCCESSION	WILDLIFE HABITAT
STEM DISEASES				
Dwarf mistletoe	++	+	+	++
Hemlock cankers	-	+	-	+
Hardwood cankers	+	+	+	-
Spruce broom rust	+	-	-	++
Hemlock bole fluting	-	-	-	+
Western gall rust	-	-	-	-
HEART ROTS				
(Many species)	++	+	++	++
ROOT DISEASES				
(several species)	+	++	++	+
FOLIAR DISEASES				
Spruce needle rust	-	-	-	-
Spruce needle blights	-	-	-	-
Hemlock needle rust	-	-	-	-
Cedar foliar diseases	-	-	-	-
Hardwood leaf diseases	-	-	-	-
SHOOT DISEASES				
Sirococcus shoot blight	-	-	-	-
Shoot blight of yellow-cedar	-	+	-	-
DECLINES				
Yellow-cedar decline	++	++	++	+
ANIMAL DAMAGE				
Porcupines	+	-	-	+
Brown Bears	+	-	-	+
Moose	+	+	-	+

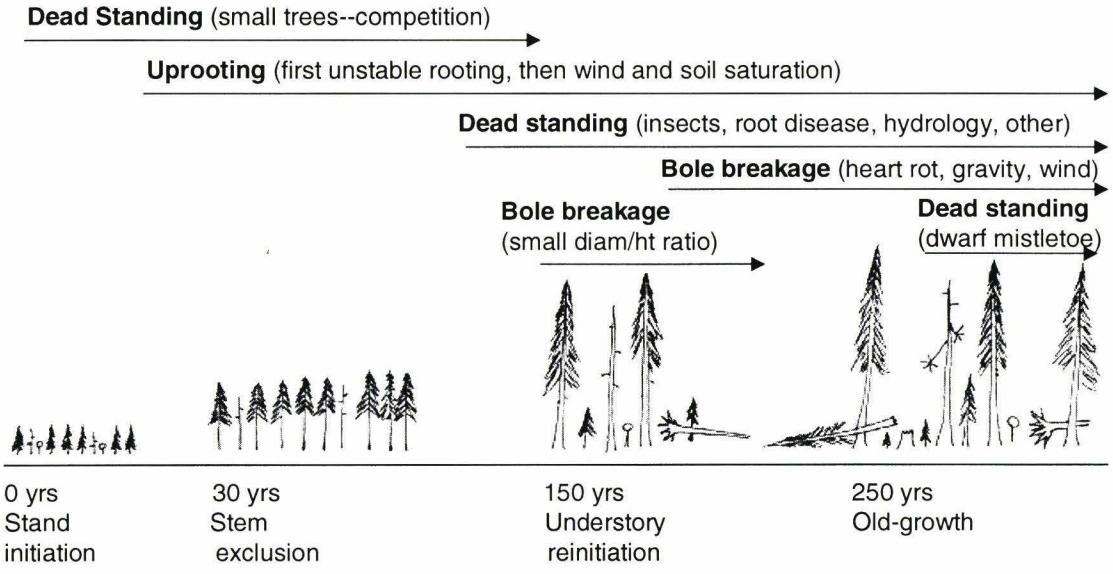


Figure 21. Stages of stand development and associated forms of tree mortality following catastrophic disturbance (e.g., clearcut or storm). Competition causes most mortality in young stands and trees usually die standing. Disease in the form of heart rot plays an active role in small-scale disturbance in the third, transitional stage and then is a constant factor in the maintenance of the old-growth stage. The time scale that corresponds to stages of stand development varies by site productivity. Many old-growth structures and conditions may be present by 250 years on some sites in Southeast Alaska. The old-growth stage may persist for very long periods of time in protected landscape positions.

STEM DISEASES

Hemlock Dwarf Mistletoe

Arceuthobium tsugense (Rosendhal) G.N. Jones

Hemlock dwarf mistletoe is an important disease of western hemlock in unmanaged, old-growth stands throughout southeast Alaska as far north as Haines. Although the range of western hemlock extends to the northwest along the Gulf of Alaska, dwarf mistletoe is absent from Cross Sound to Prince William Sound (M244A, 245A, and M245A)*. The incidence of dwarf mistletoe varies in old-growth hemlock stands in southeast Alaska from stands in which every mature western hemlock tree is severely infected to other stands in which the parasite is absent. The dominant small-scale (canopy gap) disturbance pattern in the old forests of coastal Alaska favors the short-range dispersal mechanism of hemlock dwarf mistletoe and may explain the common occurrence of the disease here. Infection of Sitka spruce is uncommon and infection of mountain hemlock is rare. The disease is uncommon on any host above elevations of approximately 1,000 feet. Heavily infected western hemlock trees have branch proliferations (witches' brooms), bole deformities, reduced height and radial growth, less desirable wood characteristics, greater likelihood of heart rot, top-kill, and severely infected trees may die. We have found the aggressive heart rot fungus *Phellinus hartigii* associated with large mistletoe brooms on western hemlock.

Figure 22. Large brooms are the most visible characteristic of hemlock dwarf mistletoe.

These symptoms are all potential problems in stands managed for wood production. Growth loss in heavily infested stands can reach 40% or more. On the other hand, witches' brooms, wood decay associated with bole infections, and scattered tree mortality can result in greater diversity of forest structure and increased animal habitat. Witches' brooms may provide hiding or nesting habitats for birds or small mammals, although this topic has not been adequately researched in Alaska. The inner bark of swellings and the seeds and shoots of the parasitic plants are nutritious and often consumed by small mammals (e.g., most likely flying squirrels). However, heavily infected hemlock stands can begin to decline and collapse to the extent that vertical structural diversity and animal habitat are diminished. Stand composition is altered when mixed-species stands are heavily infected; growth of resistant species such as Sitka spruce and cedar is enhanced.

Spread of the parasite into young-growth stands that regenerate following "clear cutting" is typically by: 1) infected non-merchantable hemlock trees (residuals) which are sometimes left standing in cut-over areas, 2) infected old-growth hemlocks on the perimeter of cut-over areas, and 3) infected advanced reproduction. Residual trees may play the most important role in the initial spread and long-term mistletoe development in young stands. Managers using alternative harvest techniques (e.g., large residuals left standing in clearcuts, small harvest units, or partial harvests) should recognize the potential reduction in timber volume and value from hemlock dwarf mistletoe under some of these silvicultural scenarios. But substantial reductions to timber are only associated with very high disease levels. High levels of hemlock dwarf mistletoe will only result if numerous, large, intensely-infected hemlocks are well-distributed after harvest. Mistletoe management appears to be a good tool in balancing several resource objectives. Selective harvesting techniques will be the silvicultural method for maintaining desirable levels of this disease if management intends to emphasize structural and biological diversity along with timber production.

---

* The number following place names refer to ecosystem section designations. Refer to page 6 and Appendix D.

Hemlock Canker

Xenomeris abietis Barr. and other fungi

Hemlock canker, which occurred at outbreak levels in southeast Alaska during the early 1990's, was conspicuous again in late 1999 on the Rowan Bay Road system of Kuiu Island and in the West Arm of Cholmondeley Sound on Prince of Wales Island. In past outbreaks, it has been common along unpaved roads on Prince of Wales Island, Kuiu Island (Rowan Bay road system), Chichagof Island (Corner Bay road system) and near Carroll Inlet on Revillagigedo Island (M245B). It was also observed in several roadless areas. This year, it was reported to be common on the Rowan Bay road system of Kuiu Island.

The causal agent has not been conclusively determined. Road dust and a fungus appear to be responsible for outbreaks of this disease. Ecologically, stand composition and structure are the primary effects of hemlock canker. Tree species, other than western and mountain hemlock, are resistant and benefit from reduced competition. Wildlife habitat, particularly for deer, may be enhanced where the disease kills understory hemlock; which tends to out-compete the more desirable browse vegetation.

Spruce Broom Rust

Chrysomyxa arctostaphyli Diet.

Broom rust is common on spruce throughout interior and south-central Alaska but is found in only several local areas of southeast Alaska (e.g., Halleck Harbor area of Kuiu Island and Glacier Bay (M245B)). The disease is abundant only where spruce grow near the alternate host, bearberry or kinnikinnick (*Arctostaphylus uva-ursi*) in Alaska. The fungus cannot complete its life cycle unless both host types (spruce and bearberry) are present.

Infections by the rust fungus result in dense clusters of branches or witches' brooms on white, Lutz, Sitka, and black spruce. The actual infection process may be favored during specific years, but the incidence of the perennial brooms changes little from year to year.

The disease may cause slowed growth of spruce, although this has not been determined by research. Witches' brooms may serve as entrance courts for heart rot fungi, including *Phellinus pini*.

Ecologically, the dense brooms provide important nesting and hiding habitat for birds and small mammals. In interior Alaska, research on northern flying squirrels suggests that brooms in white spruce are an important habitat feature for communal hibernation and survival in the coldest periods of winter.

Western Gall Rust

Peridermium harknessii J.P. Moore

Infection by the gall rust fungus *P. harknessii* causes spherical galls on branches and main boles of shore pine. The disease was common throughout the distribution of pine in Alaska in 1999 (M244B & C, M245B). Infected pine tissues are swollen but not always killed by the rust fungus. Another fungus, *Nectria macrospora*, colonized and killed many of the pine branches with *P. harknessii* galls this year. The combination of the rust fungus and *N. macrospora* frequently caused top-kill. The disease, although abundant, does not appear to have a major ecological effect in Alaskan forests.

HEART ROTS OF CONIFERS

Heart rot decay causes enormous loss of wood volume in Alaskan forests. Approximately 1/3 of the old-growth timber volume in southeast Alaska is defective largely due to heart rot fungi. These extraordinary effects occur where long-lived tree species predominate in such as old-growth forests in southeast Alaska. The great longevity of individual trees allows ample time for the slow-growing decay fungi to cause significant amounts of decay. Wood decay fungi play an important role in the structure and function of coastal old-growth forests where fire and other forms of catastrophic disturbance are uncommon. By predisposing large old trees to bole breakage, these fungi serve as important disturbance factors that cause small-scale canopy gaps. All major tree species in southeast Alaska are susceptible to heart rot decay and bole breakage.

In south-central and interior Alaska, heart rot fungi cause considerable volume loss in white spruce forests. Most heart rot fungi apparently enter trees through natural wounds, including dead or broken branches, frost cracks, and bole wounds. We have a limited understanding of the role of heart rot fungi in forest development. In the boreal forests, large-scale disturbance agents, including wildfire, insect outbreaks (e.g., spruce beetle), and flooding, are key factors influencing forest structure and composition. The

importance of small-scale disturbances caused by decay fungi is unknown.

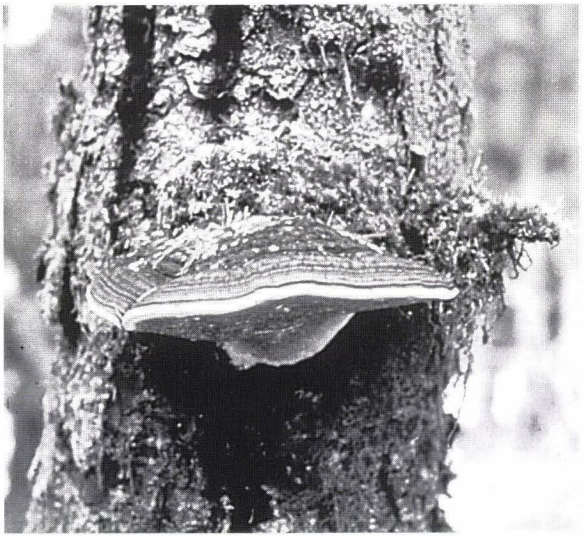


Figure 23. ***Fomitopsis pinicola*** *is an important heartrot fungus in live trees but also a dominant decomposer of dead trees.*

Heart rot fungi enhance wildlife habitat -- indirectly by increasing forest diversity through gap formation and more directly by creating hollows in live trees or logs for species such as bears and cavity nesting birds. Wood decay in both live and dead trees are centers of biological activity, especially for small organisms. Wood decay is the initial step in nutrient cycling of wood substrates, has associated bacteria that fix nitrogen, and contributes large masses of stable structures (e.g., partially modified lignin) to the humus layer of soils.

The importance of decay fungi in managed young-growth conifer stands is less certain. Wounds on live trees caused by logging activities allow for the potential of decay fungi to cause appreciable losses. Heart rot in managed stands can be manipulated to desirable levels by varying levels of bole wounding and top breakage during stand entries. In some instances, bole breakage is sought to occur in a specific direction (e.g., across streams for coarse woody debris input). Artificially wounding trees on the side of the bole that faces the stream can increase the likelihood tree fall in that direction. In southeast Alaska, a study has been concluded that investigated how frequently fungi enter wounds of different sizes and the rate of subsequent decay in these wounded trees. Generally, larger, deeper wounds and larger diameter breaks in tops result in a faster rate of decay. Results indicate that heart rot development is much slower in southeast Alaska than areas studied in the Pacific Northwest.

Table 4. Common wood decay organisms of live trees in Alaska

	TREE SPECIES INFECTED				
Heart and butt rot fungi*	Western hemlock	Sitka spruce	Western red cedar	White/Lutz spruce	Mountain hemlock
Laetiporus sulphureus	X	X		X	X
Phaeolus schweinitzii	X	X		X	
Fomitopsis pinicola	X	X		X	X
Phellinus hartigii	X				
Phellinus pini	X	X		X	X
Ganoderma sp.	X	X		X	
Armillaria sp.	X	X	X	X	X
Inonotus tomentosus				X	
Heterobasidion annosum	X	X			
Ceriporiopsis rivulosa			X		
Phellinus weirii			X		
Echinodontium tinctorium					X

* Some root rot fungi were included in this table because they are capable of causing both root and butt rot of conifers.

Wood decay fungi decompose branches, roots, and boles of dead trees; therefore, they play an essential role in recycling wood in forests. However, sap rot decay also routinely and quickly develops in spruce trees attacked by spruce beetles. Large amounts of potentially recoverable timber volume are lost annually due to sap rot fungi on the Kenai Peninsula, where salvage logging has not kept pace with tree mortality from the continuing spruce beetle epidemic. Significant volume loss from sap rot fungi typically occurs several years after tree death. The most common sap rot fungus associated with spruce beetle-caused mortality is *Fomitopsis pinicola*, the red belt fungus.

STEM DECAY OF HARDWOODS

Stem decay is the most important cause of volume loss and reduced wood quality in Alaskan hardwood species. In south-central and interior Alaska, incidence of stem decay fungi increases as stands age and is generally high in stands over 100 years. The most reliable decay indicator is the presence of fruiting bodies (mushrooms or conks) on the stem. Other external indicators of decay include frost cracks, broken tops, dead branch stubs, and trunk wounds. Stem decay fungi will limit harvest rotation age of forests that are managed for wood production purposes. Studies are currently underway in paper birch forests to identify the most important stem decay fungi and assess the relationships among decay, stand age, presence of decay indicators, and site factors.

Figure 24. ***Phellinus igniarius*** *conk on paper birch.*

Ecologically, stem decay fungi alter stand structure and composition and appear to be important factors in the transition of even-aged hardwood forests to mixed species forests. Bole breakage of hardwoods creates canopy openings, allowing release of understory conifers. Trees with stem decay, broken tops, and collapsed stems are preferentially selected by wildlife for cavity excavation. Several mammals, including the northern flying squirrel, are known to use tree cavities year-round for nest and cache sites.

In south-central and interior Alaska, the following fungi are the primary cause of wood decay in live trees:

Paper birch
Phellinus igniarius
Inonotus obliquus
Pholiota sp.
Ganoderma applanatum
Armillaria sp.

Trembling aspen
Phellinus tremulae
Pholiota sp.
Ganoderma applanatum
Armillaria sp.

A number of fungi cause stem decay in balsam poplar, black cottonwood, and other hardwood species in Alaska.

SHOOT BLIGHTS and CANKERS

Sirococcus Shoot Blight

Sirococcus strobilinus Pruess.

The shoots of young-growth western hemlocks were killed in moderate levels by the blight fungus *S. strobilinus* in southeast Alaska during 1999. Sitka spruce and mountain hemlock were attacked but less frequently and less severely. Thinning may be of some assistance in reducing damage by the fungus as thinned stands have fewer infections than unthinned stands.

This disease is typically of minimal ecological consequence because infected trees are not often killed and young hemlock stands are so densely stocked. Species composition may be altered to some degree where trees other than western hemlock may be favored by the disease.

Shoot Blight Of Yellow-cedar

Apostrasseria sp.

Yellow-cedar regeneration suffered infection and shoot blight by the fungus *Apostrasseria* sp. in southeast Alaska in 1999 as it does every year. The disease, however, does not affect mature cedar trees. Attack by the fungus causes terminal and lateral shoots to be killed back 10 to 20 cm on seedlings and saplings during winter or early spring. Entire seedlings up to 0.5m tall are sometimes killed. The newly discovered fungus that causes the disease, *Apostrasseria* sp., is closely related to other fungi that cause disease on plants under snow. The fungus *Herpotrichia juniperi* is often found as a secondary invader on seedlings after they die.

This shoot blight disease probably has more ecological impact than similar diseases on other host species because the natural regeneration of yellow-cedar is limited in many areas. By killing the leaders of yellow-cedar seedlings and diminishing their ability to compete with other vegetation, the pathogen reduces the regeneration success of yellow-cedar and thereby alters species composition.

Canker Fungi

Cryptosphaeria populina (Pers.) Sacc.
Cenangium singulare (Rehm.) D. & Cash
Ceratocystis fimbriata Ell. & Halst.
Cytospora chrysosperma Pers. ex Fr.
Nectria galligena Bres.

These fungi primarily cause trunk deforming cankers and wood decay of many hardwood species, particularly trembling aspen, in south-central and interior Alaska. Although most are considered weak parasites, *C. singulare* can girdle and kill a tree in three to ten years. All the canker-causing fungi were at endemic levels in 1999. Ecologically, canker fungi alter stand structure, composition, and successional patterns through trunk deformity and bole breakage.

FOLIAR DISEASES

Spruce Needle Blights

Lirula macrospora (Hartig) Darker
Lophodermium picea (Fuckel) Höhn.
Rhizosphaera pini (Corda) Maubl.

The fungus *Lirula macrospora* is the most important needle pathogen of spruce. In 1999 it occurred at moderate to low levels in most areas within the range of Sitka and white spruce. Throughout southeast Alaska, the disease was most common on young Sitka spruce and the lower crowns of larger trees. *Lophodermium picea* was present at low infection levels in 1999. This disease is more typical of larger, older trees of all spruce species in Alaska. *Rhizosphaera pini* continued at endemic levels after causing damage several years ago in coastal Alaska. Damage closely resembles that caused by spruce needle aphid. Microscopic observation of the tiny fruiting bodies on infected needles is necessary for proper identification.

The primary impact of these needle diseases is generally one of appearance. They can cause severe discoloration or thinning of crowns but typically have only negligible ecological consequence. However, repeated heavy infections may slow the growth of spruce and benefit neighboring trees, thereby altering species composition to some degree.

Spruce Needle Rust

Chrysomyxa ledicola Lagerh.
Chrysomyxa weirii Jacks.

Spruce needle rust, caused by *C. ledicola*, occurred at moderate levels across the state except in southeast Alaska where the disease was found at the highest levels in recent memory. Scattered outbreaks occurred in white spruce across south-central and interior Alaska in 1999. An extensive but unmeasured outbreak occurred on the west side of Cook Inlet near the Chilikadrotna River (M213A). Acres attributed to this foliar disease should be considered conservative because the timing of aerial surveys is prior to peak visible expression of the disease.

The disease was epidemic in southeast Alaska in wet, boggy areas wherever spruce and Labrador-tea coexisted. Up to 100% of current-year's needles were infected in spruce in many of these areas, giving the forest a bright yellow appearance. Buds were not

infected, however, and even with such high disease levels, nearly all trees should recover.

The spores that infect spruce needles are produced on the alternate host, Labrador-tea (*Ledum spp.*), a plant that is common in boggy areas; thus the disease on spruce is most pronounced in these boggy (muskeg) areas. Although the disease can give spruce trees the appearance of being nearly dead, trees rarely die of this disease even in years of intense infection.

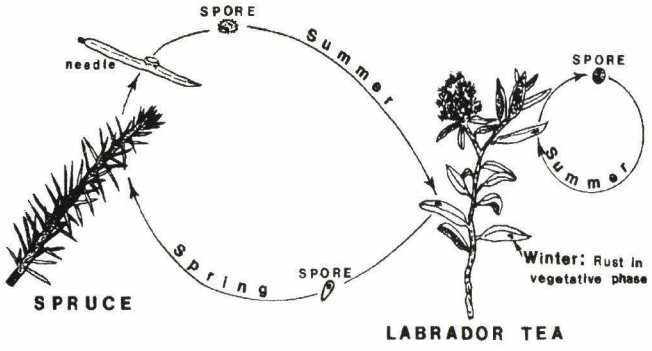


Figure 25. The life cycle requires two host plants: spruce and Labrador tea.

On Sitka spruce, the primary ecological consequence of the disease may be to reduce tree vigor of a species already poorly adapted to boggy sites. Repeated infection of spruce may alter forest composition by favoring other tree species.

The foliar rust fungus *C. weirii* was found sporulating on one-year-old Sitka spruce needles in several areas of southeast Alaska during spring but it has never been detected at threatening levels. Unlike most other rust fungi, no alternate host is necessary to complete its life cycle. Little ecological or economic impact results from this disease.

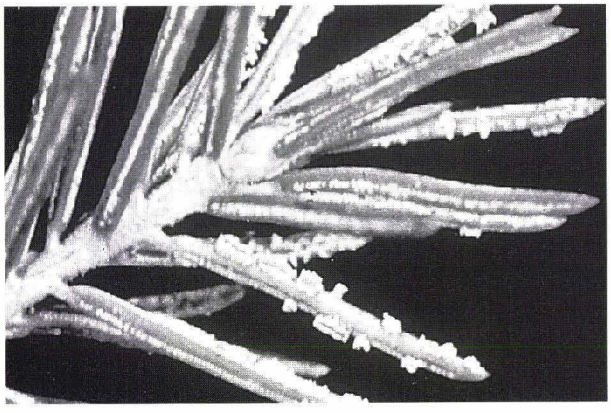


Figure 26. The small fruiting bodies of ***Chrysomyxa ledicola*** *can be seen on the needles of this spruce.*

Hemlock Needle Rust

Pucciniastrum vaccinii (Rab.) Joerst.

Hemlock needle rust was found at low endemic levels in 1999 after a high incidence three years ago. In 1996, the disease was most damaging near Yakutat (245A) where it caused defoliation of western hemlock, especially on trees growing adjacent to harvested sites. Elsewhere, infected needles were found, but hemlock trees were not heavily defoliated. The alternate hosts for the rust fungus include several blueberry species (*Vaccinium*). Infection levels usually return to endemic levels in a year or so and the disease is not expected to influence major ecological change.

Willow Rust

Melampsora epitea Thuem.

Willow rust, caused by one or more races of *Melampsora epitea*, occurred on willow at moderate to high levels in 1999. Acres attributed to this foliar disease should be considered conservative because the timing of aerial surveys is prior to peak expression of the disease. The primary outbreak coincided with the large outbreak of the willow leaf blotchminer across the interior. The rust fungus causes a yellow leaf spot or blight on willow leaves. Tamarack is an alternative host for the rust, however, the fungus does not need to alternate to the conifer host. The rust fungus overwinters on willow leaves or buds and can infect willows in successive years. Repeated rust infection of leaves may reduce host vigor.

Foliage Diseases of Cedars

Gymnosporangium nootkatense Arth.
Didymascella thujina (Durand) Maire

Two fungi that infect the foliage of cedar, *G. nootkatense* on yellow-cedar and *D. thujina* on western redcedar, occurred at endemic levels this year. *D. thujina* was the more damaging of the two and was common wherever its host was found. Neither fungus resulted in severe defoliation or death of cedar trees. Neither disease has major ecological effects.

ROOT DISEASES

Three important tree root diseases occur in Alaska: tomentosus root rot, annosus root disease, and armillaria root disease. The laminated root disease caused by a form of the fungus *Phellinus weirii*, so important in some western forests of British Columbia, Washington, and Oregon, is not present in Alaska. A non-root disease form of the fungus is present in southeast Alaska, where it causes a white rot in western redcedar, contributing to the very high defect levels of this tree species.

Although relatively common in Alaskan forests, root diseases are often mis-diagnosed or overlooked. Recognizing root disease can be challenging because the infected tissue is primarily below ground and infected trees may be symptomless. Identification of a root disease can seldom be made solely on the basis of above-ground symptoms.

Root disease pathogens affect groups of trees in progressively expanding disease centers. Typically, disease pockets contain dead trees in the center and living, but infected trees in various stages of decline, at the edges. Root disease fungi are capable of spreading from tree to tree through root contacts. Infected trees are prone to uprooting, bole breakage, and outright mortality due to the extensive decay of root systems and the lower tree bole. Volume loss attributed to root diseases can be substantial, up 1/3 of the gross volume. In managed stands, root rot fungi are considered long-term site problems because they can remain alive and active in large roots and stumps for decades, impacting the growth and survival of susceptible host species on infected sites.

Ecologically, root diseases are considered natural, perhaps essential, parts of the forest altering stand structure, composition, and increasing plant community diversity through canopy openings and scattered mortality. Resistant tree species benefit from reduced competition within infection centers. Wildlife habitat may be enhanced by small-scale mortality centers and increased volume of large woody downed material.

Tomentosus Root Disease

Inonotus tomentosus (Fr.) Teng.

I. tomentosus causes root and butt-rot of white, Lutz, Sitka, and black spruce. The fungus can also attack lodgepole pine and tamarack. All hardwood trees are resistant to infection. The disease appears to be widespread across the native range of spruce in south-central and interior Alaska, but to date, has not been found in southeast Alaska.

Spruce trees of all ages are susceptible to infection through contact with infected roots. Infected trees exhibit growth reduction or mortality, depending on age. Younger trees may be killed outright while older trees may persist in a deteriorating condition for many years. Volume loss in older infected trees can be substantial, up 1/3 of the gross volume. Trees with extensive root and butt decay are prone to uprooting and bole breakage. Individual mortality centers (groups of infected trees) are typically small, however, coalescing centers can occupy large areas.

Figure 27 A white spruce sapling killed by the root disease ***I. tomentosus****.*

Studies in cut-over stands indicate that *I. tomentosus* will remain alive in colonized stumps for at least three decades, and successfully attack adjacent trees through root contacts. Thus, spruce seedlings planted within close proximity of infected stumps are highly susceptible to infection through contacts with infected roots. Recognition of this root disease is important in managed stands where natural regeneration of white and Lutz spruce is limited and adequate restocking requires planting.

Tomentosus root disease can be managed in a variety of ways depending on management objectives. Options for manipulating levels of root disease on

infested sites include: establishment of non-susceptible species in root rot centers (i.e., hardwood trees), avoid planting susceptible species within close proximity of diseased stumps, and removal of diseased stumps and root systems. Studies are currently underway to assess mortality in young growth stands and determine site factors that influence disease incidence and severity.

Annosus Root & Butt Rot

Heterobasidion annosum (Fr.) Bref.

Annosus commonly causes root and butt-rot in old-growth western hemlock and Sitka spruce forests in southeast Alaska (M245B, M244C). To date, *H. annosum* has not been documented in south-central or interior Alaska.

Elsewhere in the world, spores of the fungus are known to readily infect fresh stump surfaces, such as those found in clearcuts or thinned stands. Studies in managed stands in southeast Alaska, however, indicate limited stump infection and survival of the fungus. Thus, this disease poses minimal threat to young managed stands with stump top infection.

Reasons for the limited stump infection may be related to climate. High rainfall and low temperatures, common in Alaska's coastal forests, apparently hinder infection by spores.

Armillaria Root Disease

Armillaria spp.

Several species of *Armillaria* occur in the coastal forests of southeast Alaska, but in general, the species are less-aggressive, saprophytic decomposers that only kill trees when they are under some form of stress. Studies in young managed stands indicate that *Armillaria sp.* can colonize stumps, but will not successfully attack adjacent trees.

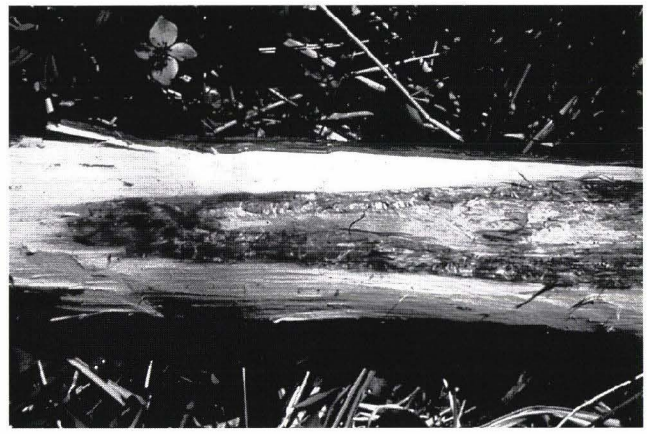


Figure 28. A lesion of dead tissue colonized by ***Armillaria.***

Several species of *Armillaria* occur in south-central and interior Alaska, some attack conifers while others attack hardwoods. Most species appear to be weak pathogens invading trees under stress. Research is currently underway to determine the species present and their impacts in the boreal forests.

DECLINES AND ABIOTIC FACTORS

Yellow-cedar Decline

Decline and mortality of yellow-cedar persists as one of the most spectacular forest problems in Alaska. Approximately 479,000 acres of decline have been mapped during aerial detection surveys. Concentrated mortality occurs in a wide band from western Chichagof and Baranof Islands to the Ketchikan area (M245B).

All research suggests that contagious organisms are not the primary cause for this extensive mortality. Some site factor, probably associated with poorly-drained anaerobic soils, appears to be responsible for initiating and continuing cedar decline. Two hypotheses have been proposed to explain the primary cause of death in yellow-cedar decline:

- Toxins are produced by decomposition in the wet, organic soils, or
- Shallow fine roots are damaged from freezing, associated with climatic warming and reduced insulating snowpack in the last century.

These hypotheses are developed in some detail (Hennon and Shaw 1994, 1997). Interestingly, considerable concentrations of newly-killed trees were evident in declining forests during 1996 and 1997, perhaps a response to the unusually prolonged cold temperatures with little snowpack that persisted during the previous two winters. Whatever the primary cause of this mysterious decline, all available information indicates that it is probably a naturally-occurring phenomenon. We initiated preliminary investigations this year in the areas of soils and hydrology with more detailed research planned for next year.

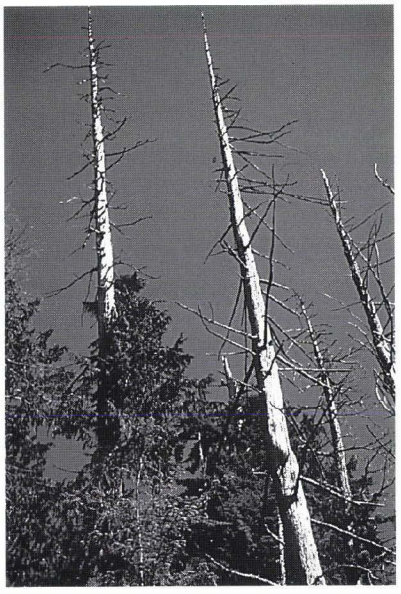


Figure 29. Death of overstory yellow-cedar trees favors other tree species.

Research suggests that the total acreage of yellow-cedar decline has been increasing very gradually; the slow increase in area has been a result of the expansion of existing decline (<3 feet/year). Most stands contain trees that died up to 100 years ago (snags still standing), as well as recently killed cedars, dying cedars (with yellow, red, or thinning crowns), healthy cedars, and other tree species.

Ground surveys show that 65% of the basal area of yellow-cedar is dead on this acreage. Other tree species are affected in different ways: on some sites they produce increased growth, presumably due to less competition, and on other sites they experience slowed growth and mortality due to deteriorating site conditions (poor drainage). Species change to western hemlock and mountain hemlock and large increases in understory biomass accumulation for brushy species appear to be occurring in some stands where decline has been ongoing for up to a century.

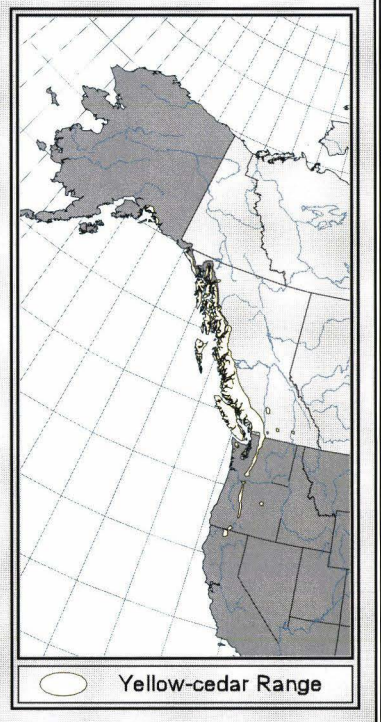
The primary ecological effect of yellow-cedar decline is to alter stand structure (i.e., addition of numerous snags) and composition (i.e., yellow-cedar diminishing and other tree species becoming more numerous) that leads to eventual succession favoring other conifer species. The creation of numerous snags is probably not particularly beneficial to cavity-using animals because yellow-cedar wood is less susceptible to decay. Region-wide, this excessive mortality of yellow-cedar may lead to diminishing populations (but not extinction) of yellow-cedar, particularly when the poor regeneration of the species is considered.

The large acreage of dead yellow-cedar and the high value of its wood suggest opportunities for salvage. Cooperative studies with the Wrangell Ranger District, the Forest Products Laboratory in Madison, Wisconsin, Oregon State University, and State and Private Forestry are investigating the mill-recovery and wood properties of snags of yellow-cedar that have been dead for varying lengths of time. This work includes wood strength properties, durability (decay resistance), and heartwood chemistry.

Little is known about wildlife use and dependency of yellow-cedar forests. In 1998, we initiated a study to evaluate birds' use of each of the snag classes as nesting or feeding habitat. In a companion study we are investigating the insect community on dead cedars; insects on recently killed trees may be an important prey source for insectivorous birds.

Yellow-Cedar Decline on the Tongass

Yellow-cedar, which has the most valuable wood in Alaska, has experienced a problem of decline and mortality on nearly 1/2 million acres throughout southeast Alaska. We are studying factors that cause tree death and learning how to establish new cedar forests. We are also evaluating dead yellow-cedar as a resource.



Juneau

Sitka

Petersburg

Wrangell

Craig

Ketchikan

UNITED STATES

CANADA

GULF OF ALASKA

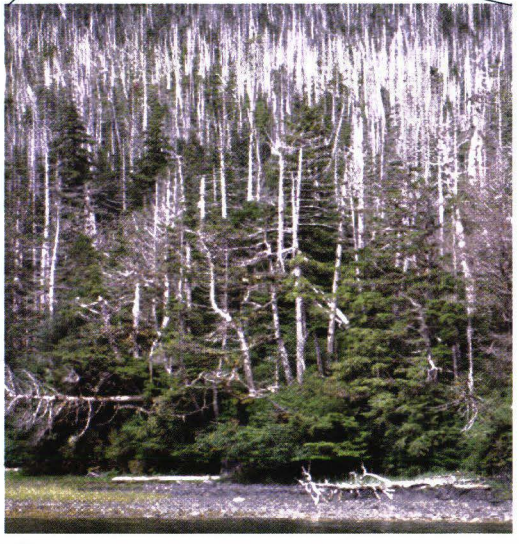
DIXON ENTRANCE

N

Glacier

Nonforested

Cedar-decline



USDA Forest Service
Forest Health Protection
Date Printed: 1/1/2000

0 25 50 75 100 Miles

Table 5. Acreage affected by yellow-cedar decline in southeast Alaska in 1999 by ownership

	Acres
NATIONAL FOREST LAND	***449,395***
Chatham Area Total	***116,451***
Juneau Ranger District	865
Hoonah Ranger District	1,058
Sitka Ranger District	
Chichagof I	33,489
Baranof I	48,712
Kruzof I	26,908
Sub-total	109,109
Admiralty Island Nat'l Mon. Wilderness	5,419
Stikine Area Total	***205,725***
Petersburg Ranger District	
Kupreanof I	82,226
Kuiu I	65,566
Mitkof I	5,884
Woewodski I	2,315
Mainland	6,710
Sub-total	162,701
Wrangell Ranger District	
Etolin I	17,051
Wrangell I	9,147
Zarembo I	3,969
Woronofski I	441
Mainland	12,416
Sub-total	43,024
Ketchikan Area Total	***127,219***
Craig Ranger District	
Prince of Wales I	27,580
Dall I and Long I	901
Sub-total	28,481
Ketchikan Ranger District	
Revillagigedo I	13,786
Gravina I	809
Mainland	13,765
Sub-total	28,360
Ketchikan Area (continued)	
Thorne Bay Ranger District	
Prince of Wales I	30,304
Kosciusko I	11,862
Heceta I	1,044
Sub-total	43,210
Misty Fjords Nat'l Mon. Wilderness	
Revillagigedo I	8,998
Mainland	18,170
Sub-total	27,168
NATIVE LAND	***20,462***
Prince of Wales I	9,377
Dall and Long I	675
Kupreanof I	5,061
Baranof and Kruzof I	390
Chichagof I	714
Revillagigedo I	2,285
Annette I	984
Kuiu I	98
Mainland	878
STATE & PRIVATE LAND	***23,563***
Admiralty I	9
Baranof I	3,100
Dall and Long I	62
Chichagof I	1,142
Gravina I	1,317
Mitkof I	1,678
Kosciusko I	548
Kuiu I	897
Kupreanof I	1,687
Prince of Wales I	4,536
Wrangell area	2,101
Revillagigedo	3,742
Kruzof I	299
Other Mainland	2,445
Other Federal	***323***
Baranof I	323
Total Land Affected	***493,743****

*Acreage by ownership was tabulated using Alaska land status data from ADNR. In prior years a different ownership layer was used to tabulate this information. Other changes in acreage figures are due to a change in the resource, refined sketch-mapping or changes in GIS techniques.

Water Damage

Flood damage was noted on over 2500 acres in scattered locations across the state. In south-central and interior Alaska, flood damage occurs annually to conifer and hardwood stands adjacent to rivers and lakes.

Hemlock Fluting

Deeply incised grooves and ridges extending vertically along boles of western hemlock characterize hemlock fluting. Fluting is distinguished from other characteristics on tree boles, such as old callusing wounds and root flaring, in that fluting extends near or into the tree crown and fluted trees have more than one groove. Bole fluting is common on western hemlock in many areas of southeast Alaska. This condition reduces the value of hemlock logs because they yield less sawlog volume and bark is contained in some of the wood. The cause of fluting is not completely known, but associated factors include: increased wind-firmness of fluted trees, shallow soils, and a triggering mechanism during growth release (e.g., some stand management treatments). The asymmetrical radial growth appears to be caused by unequal distribution of carbohydrates due to the presence of dead branches. Researchers have documented the development of fluting in young hemlock stands that regenerated following clearcut harvesting or other disturbance. After several centuries, fluting sometimes is no longer outwardly visible in trees because branch scars have healed over and fluting patterns have been engulfed within the stem.

Bole fluting has important economic impact, but may have little ecological consequence beyond adding to windfirmness. The deep folds on fluted stems of western hemlock may be important habitat for some arthropods and the birds that feed upon them (e.g., winter wren).

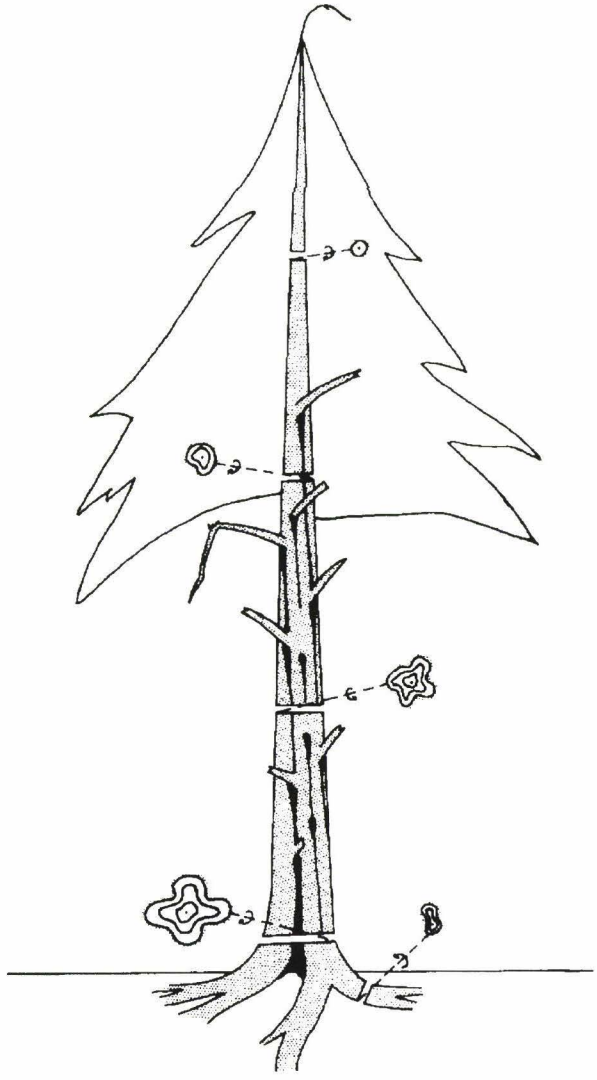


Figure 30. Hemlock Fluting Branches disrupt the vertical flow of carbohydrate in the stem causing annual rings to become asymmetrical. Flutes originate beneath decadent branches and extend downward, forming long grooves where other branches are intersected. ***(Figure and caption from Julin, K.R.; Farr, W.A. 1989. Stem Fluting of Western Hemlock in Southeast Alaska).***

Porcupine

Erethizon dorsatum

Porcupines cause severe damage to Sitka spruce and western hemlock trees in numerous local areas of southeast Alaska. An extensive survey has documented the level of porcupine damage in young-growth stands. Feeding injuries to trees are confined to the known distribution of porcupine. Damage is especially serious on Mitkof Island in southeast Alaska. Other damage has been noted at Thomas Bay, Cleveland Peninsula, Bradfield Canal, Anita Bay and other areas of Etolin Island, Douglas Island, and the Juneau area (M245B). Porcupines also damage trees throughout interior Alaska. Bark beetles, including *Ips* spp., have been found infesting the damaged trees.

In southeast Alaska, the feeding behavior of porcupines changes as forests develop and trees become larger and older. Porcupines climb smaller trees and kill or cause topkill by removing bark along the entire bole, or the bole near the top of the tree. As trees become larger, around 40-50 years old, most of the damage is in the form of basal wounding. Most of these larger trees are not killed, but the large basal scars allow fungi to enter the bole and begin to cause wood decay.

The primary ecological consequences of porcupine feeding are: (1) to provide greater diversity of structure and vegetation in young, even-aged conifer stands through mortality and (2) to provide greater levels of heart rot decay by wounding older trees. This latter effect can alter mortality patterns in old forests as trees may often die through bole breakage.

Bear

Ursus arctos
Ursus americanus

Yellow-cedar trees were wounded in the spring by brown bears on Baranof and Chichagof Islands (M245B). Brown bears rip the bark away from the lower boles of these trees, apparently to lick the sweet cambium. The majority of yellow-cedar trees in some stands have basal wounds from bear feeding. Other tree species in southeast Alaska are unaffected. Black bears caused injury to the lower boles of white and Lutz spruce and occasionally aspen in the lowland forests of the Kenai Peninsula (213B). Trees with old scars may have associated columns of wood decay that will limit the value of their butt logs.

Moose

Alces alces

At many locations across south-central and interior Alaska, moose cause severe damage to hardwood species by repeatedly browsing stems and wounding tree boles. In the winter, moose congregate in areas containing young hardwoods, often consuming the new growth on the same trees year after year. Snow cover typically protects stems less than 20 inches tall, while branches or tree tops greater than 12 feet tall are generally out of reach and escape browsing damage. Browsing also occurs on the bole of live trees, particularly aspen and willow. Heavy, repeated browsing results in stunted malformed stems, wounds, and mortality. Wood decay fungi are known to invade trunk wounds caused by moose.

Snowshoe Hare

***Lepus* sp.**

Bole wounds, terminal and lateral bud damage, and seedling mortality were attributed to browsing by snowshoe hares on hardwoods and conifers in the interior. Old damage to mature trees and new damage to seedlings was evident in surveys of pre-commercially thinned white spruce stands near Tok. In the past, hare browsing of the terminal and lateral buds killed the main stem leader; the characteristic angled browse mark is still evident on the dead leader. Live mature trees retain the dead leader but have a pronounced stem crook at the point where a lateral branch became dominant following leader death. The dead leaders provided an infection court for heart rot by *Phellinus chrysoloma*. New terminal and lateral bud browsing was evident on white spruce, paper birch, and aspen seedlings across the Interior. Recovery potential of trees following severe browsing in not known.

APPENDICES

INTEGRATED PEST MANAGEMENT ..... A

SUBMITTING INSECTS AND DISEASES FOR IDENTIFICATION ..... B

BIOLOGICAL EVALUATIONS, TECHNICAL REPORTS, AND PUBLICATIONS C

ECOMAP SECTION DESCRIPTIONS ..... D

WORLD WIDE WEB LINKS ..... E

INFORMATION AVAILABLE FROM STATEWIDE AERIAL SURVEYS ..... F

APPENDIX A

INTEGRATED PEST MANAGEMENT

Integrated pest management (IPM) has been described as a "systems approach to alter pest damage to acceptable levels through a variety of techniques, including predators and parasites, genetically resistant hosts, natural environmental modifications, and when necessary and appropriate, chemical pesticides." Current IPM activities in Region 10 include:

- Participation in a cooperative effort with the Alaska Cooperative Extension (ACE) to provide pest management information to Alaska residents. The program, which includes education, research and survey activities, also provides integrated pest management information concerning urban forestry as well as garden and greenhouse pests. The program is educational in nature and provides the public with a means to learn about pest management in an informal and accessible manner. 1999 IPM Technicians were located in Fairbanks, Delta, Palmer, Anchorage, and Soldotna. The Anchorage office had two full time technicians; the remaining locations had one seasonal IPM Technician from May through the end of September. The total recorded client contacts reached well over 4500; which were more than 50% of all contacts made by Cooperative Extension. The 1999 Technicians conducted more than 1,200 educational contacts including workshops and more than forty media contacts (newspaper articles, television and radio "spots") and more than 300 site visits with more than 2,500 clients assisted via phone calls and walk-in requests. More than 50% of the IPM Technician activities occurred in the Anchorage Bowl; home to more than 40% of the state population. In addition, there is now an IPM Technician Home Page <http://www.go2net.org/pest>. This home-page describes the program and has a wealth of IPM information pertinent to Alaska.

- A spruce beetle antiaggregant field study utilizing Lindgren funnel traps was undertaken in the Anchorage Bowl in 1999 with the help of the Alaska Cooperative Extension IPM Technicians. MCH, the antiaggregant of the spruce beetle, has shown promise in reducing the number of successful attacks on standing trees. However, MCH is currently formulated and available in a bubble cap release system. The release rate of MCH bubble caps is mainly determined by ambient temperature. Such a system has proved problematic in past field studies. A new release system has been developed and is not dependent on temperature for the elution of MCH. The 1999 funnel trap study utilizing the new release system proved quite effective. We will test this release device as to its effectiveness in reducing attacks on standing spruce next summer.

- In S.L. Wood's 1982 Monograph [The Bark and Ambrosia Beetles of North and Central America], there is a reference that *Ips perturbatus* is very similar to *Ips typographus*, commonly referred to as the European spruce beetle. *I. perturbatus* has always been a sporadic tree killer of white spruce in interior Alaska In recent years, however, it has caused extensive mortality of small diameter spruce on the Kenai Peninsula. The specific semiochemicals of *I. perturbatus* are currently being identified. Past pheromone trapping, using *cis*-verbenol and racemic ipsdienol, have resulted in heavy trap catches. Previous research has shown that ipsenol will reduce trap catches of *I. perturbatus* and may serve as an antiaggregant. In 1999, we installed a field study utilizing ipsenol in a bubble cap formulation with the hopes of reducing *Ips* attacks and brood development in fresh logging debris. The results of the study show the opposite; more attacks occurred on the treated plots than the untreated checks. Further trapping studies showed that the addition of ipsenol to ipsdienol and *cis*-verbenol significantly enhances trap catches. We have now determined that the attractant pheromone is a tertiary blend. Next year's field studies will focus on the role of verbenone (identified as being produced by *I. perturbatus*) as an antiaggregant.

- Yellow-cedar wood is often devalued because of dark-staining. Some evidence suggests that insects are involved in introducing a dark-staining fungus. Wood boring insect tunnels were found in association with the dark stained areas. Since these wood wasps are believed to have only a one year life cycle, many of them can be reared from infested logs and isolations can be made from the sac at the base of the ovipositor (of the females). It can then be

determined if dark-stain fungi are being inoculated into trees at the time of egg laying. Wood wasps in other tree species are known to introduce decay fungi. Isolations reveled *Sporidesmium* sp. and *Phialophora melinii* as two of the most common dark fungi.

- The spread and intensification of hemlock dwarf mistletoe is currently under study in even-aged stands, stands that have received different selective harvest treatments, and stands that experienced extensive wind damage 115 years ago. Plots within these stands have been used to quantify the short, medium, and long-term effects of the disease under different selective harvesting strategies. Results show a substantial difference by stand management. Impact of the disease is light to absent in later developmental stages of single-cohort stands but can be severe under some forms of selective harvesting. This indicates a remarkable range of disease severity that can be related to simple measures of inoculum load at the time of harvest. Distances and intensities of spread are being determined to provide information so that managers can design appropriate harvesting scenarios in relation to expected disease levels.

APPENDIX B

SUBMITTING INSECTS AND DISEASES FOR IDENTIFICATION

The following procedures for the collection and shipment of specimens should be used for submitting samples to specialists:

I. Specimen collection:

1. Adequate material should be collected
2. Adequate information should be noted, including the following:
    a. Location of collection
    b. When collected
    c. Who collected the specimen
    d. Host description (species, age, condition, # of affected plants)
    e. Description of area (e.g., old or young forest, bog, urban);
    f. Unusual conditions (e.g., frost, poor soil drainage, misapplication of fertilizers or pesticides?).
3. Personal opinion of the cause of the problem is very helpful.

II. Shipment of specimens:

1. General: Pack specimens in such a manner to protect against breakage.
2. Insects: If sent through the mail, pack so that they withstand rough treatment.
    a. Larvae and other soft-bodied insects should be shipped in small screw-top vials or bottles containing at least 70% isopropyl (rubbing) alcohol. Make certain the bottles are sealed well. Include in each vial adequate information, or a code, relating the sample to the written description and information. Labels inserted in the vial should be written on with pencil or India ink. Do not use a ballpoint pen, as the ink is not permanent.
    b. Pupae and hard-bodied insects may be shipped either in alcohol or in small boxes. Specimens should be placed between layers of tissue paper in the shipping boxes. Pack carefully and make certain that there is very little movement of material within the box. Do not pack insects in cotton.
3. Needle or foliage diseases: Do not ship in plastic bags. Sprinkle lightly with water before wrapping in newspaper. Pack carefully and make sure that there is very little movement of material within the box. Include the above collection information. For spruce and other conifers, include a description of whether current year's-needles, last-year's needles, or old-needles are attacked.
4. Mushrooms and conks (bracket fungi): Do not ship in plastic bags. Either pack and ship immediately, or first air dry and then pack. To pack, wrap specimens in dry newspaper and pack into a shipping box with more newspaper. If on wood, include some of the decayed wood. Be sure to include all collection information.

III. Shipping:

1. Ship as quickly as possible, especially if specimens are fresh and not air-dried. If samples cannot be shipped rapidly, then store in a refrigerator.
2. Include address inside shipping box.
3. Mark on outside: "Fragile: Insect-disease specimens enclosed. For scientific purposes only. No commercial value."

APPENDIX C

BIOLOGICAL EVALUATIONS, TECHNICAL REPORTS, AND PUBLICATIONS

Degroot, R.C.; Woodward, B.; Hennon P.E. 2000. Natural decay resistance of heartwood from dead, standing yellow-cedar trees: laboratory evaluations. Forest Products Journal 50: 53-59.

Hennon, P.E. 1999. *Tsuga heterophylla*. Enzyklopadie der Holzgewachse, Landsberg, Germany: Ecomed Verlagsgesellchaft. 17: 1-8.

Hennon, Paul E.; McClellan, Michael H. 1999. Heart rot and other causes of small-scale disturbance in the temperate rain forests of southeast Alaska. In: Trummer, L., comp. Proceedings of the forty-sixth Western International Forest Disease Work Conference; 1998 Sep. 28-Oct. 2; Reno, NV. Anchorage, AK: U.S. Dep. Agric., For. Ser.: 97-105.

Hennon, Paul; Wittwer, Dustin; Stevens, John. 1999. Evaluating the Dead Yellow-cedar Resource on the Tongass National Forest. Alaska value-added forest products. Sitka, AK: U.S. Dep. Agric., For. Ser., Pac. NW Res. Sta. Sept 27-28, 1999. Sitka Alaska. Poster.

Holsten, E.H. 1999. *Ips* HTML Text Book; **www.fs.fed.us/r10/spf/fhpr10.htm**

Holsten, E.H.; Gibson, K.; Munson, S. and R. Thier. 1999. The Spruce Beetle. FI&DL No. 127 (revised), USDA For. Serv. 12 pp.

Schultz, M.E.; Hennon, P.E.; and D. Wittwer. 1999. Yellow-Cedar Heartwood Stain: What causes the concentric bands of stained wood? In: 1999 Joint Proceedings of the Western International Forest Disease and Western Forest Insect Work Conference, Breckenridge, CO. (in press)

Schultz, M.E.; Hennon, P.E.; and D. Wittwer. 1999. Spruce beetle and plant succession in the glacial rebound areas of Glacier Bay National Park. In: 1999 Joint Proceedings of the Western International Forest Disease and Western Forest Insect Work Conference, Breckenridge, CO. (in press).

Thistle, H.W.; Shea, P.; Holsten, E.; and D. Quilici. 1998. Pheromone dispersion in the canopy trunk space. In: The 1998 Brighton Conference: Pest and Disease-Proceedings of an International Conference held at The Brighton Centre & The Stakis Brighton Metropole Hotel, Brighton, UK, 16-19 November 1998.

Trummer, L.M.; Hennon, P.E.; Hansen, E.M.; Muir, P. 1998. Modeling the incidence and severity of hemlock dwarf mistletoe in 110-year old wind-disturbed forests of southeast Alaska. Can. J. For. Res. 28: 1501-1508.

Trummer, L. 1999. Tomentosus root rot. USDA Forest Service, Alaska Region Leaflet, R10-TP-80. Pamphlet, color illus.

Trummer, L. 1999. The artillery fungus, a mulch problem in Alaska? USDA Forest Service, Alaska Region Forest Health Protection Biolog. Eval. R10-TP-81. 5p.

Trummer, L. and Ott, R. 1999. Decay of white spruce in pre-commercially thinned stands in Tok, Alaska. USDA Forest Service, Alaska Region Forest Health Protection Biolog. Eval. R10-TP-78. 12p.

Wittwer, D.; Matthews, K.; Zogas, K.; Trummer, L.; Holsten, E.; Schulz, B.; Hennon, P.; Schultz, M.; Riggs, J.; Burnside, R. 1998. Forest Insect and Disease Conditions in Alaska--1998. USDA Forest Service, Alaska Region, FHM. Gen. Tech. Rep. R10-TP-74. 57 p.

Zogas, K., and E.H. Holsten. 1999. Bibliography/Alaska Region Forest Health Protection. USDA Forest Service, Alaska Region, FHP Technical Report R10-TP-79. 142 pp.(electronic version available at: www.fs.fed.us/r10/spf/fhpr10.htm

APPENDIX D

ECOMAP SECTION DESCRIPTIONS

The Sections included in this report are briefly described below, along with descriptions of the appropriate Domains, Divisions, and Provinces. The prefix "M" attached to codes represents mountainous Sections where soil and vegetation zones are present. Fire frequency classification at the section level is adopted from Gallant et al (1995). The classification categories are based on frequency of lightning fires and are as follows: very low (less than 1 fire/year), low (1-5 fires/year), common (6-10 fires/year), very common (11-20 fires/year), and frequent (more than 20 fires/year). Typical insect damage are noted for each Section.

100 Polar Domain: Climate is controlled primarily by polar air masses. Winters are severe and total annual precipitation is small.

120 Arctic Division: Along the northern fringes of North America, with very short, cool summers and long, severe winters. Soil derived from mechanical breakup of rock with little to no chemical alteration. Permafrost layer can be up to 1000 feet in depth, with seasonal thaw reaching only 4 - 24 inches below the surface. Vegetation is dominated by grasses, sedges, lichens, and willow shrubs. Forest vegetation occurs only in the most southern areas.

125 Brooks Range Tundra Province: The Brooks Range is a northern extension of the Rocky Mountains. The Province is characterized rugged, deeply dissected mountains carved from uplifted and folded sedimentary rock, broad u-shaped valleys, and moraine topography of rolling plateaus and foothills.

M125A Brooks Range Mountain Section: The arctic climate and unstable slopes limit vegetation to dwarf scrub willow and lichen throughout most of the region. Sparse forest vegetation is found along rivers and flood plains. White spruce, birch, aspen, black spruce and balsam poplar occur in the most southern portions of the Section. Wildfires are fairly common. Defoliators, bark beetles and needle rust have been noted.

130 Subarctic Division: Climate has great seasonal range. Permafrost prevails under large areas. Despite low temperatures and long winters, the valleys were not glaciated during the Pleistocene. Boreal forests and open woodlands with abundant lichen predominate.

131 Yukon Intermontane Taiga Province: Series of broad valleys covered with alluvial deposits and low mountains and hills. The Province lies between the Brooks and Alaska Ranges, with Yukon, Tanana, Koyukuk, and upper Kuskokwim rivers providing drainage. The climate is semi-arid. Forest vegetation includes white spruce and hardwoods along river bottoms and uplands near rivers, and black spruce dominates on uplands.

131A Yukon Bottomlands Section: Closed forests of spruce, birch, and aspen on better drained sites, open black spruce forests on wetlands interspersed with willow thickets. Wetlands occupy much of the land cover, and permafrost is wide spread but discontinuous. Wildfire is frequent. Insect damage reported in the past includes spruce, larch, aspen, and willow defoliators along with bark beetles.

131B Kuskokwim Colluvial Plain Section: Forest vegetation includes spruce-poplar forests, open black spruce woodlands, and flood plain thickets of willow and alder. Wildfire is very common to frequent and river flooding frequent in the spring. Surveys can hampered by poor visibility due to smoke from wildfires. Insect damage includes larch, aspen, and willow defoliation, and *Ips*.

M131A Upper Kobuk-Koyukuk Section: Forests of white and black spruce, birch, and aspen occur on well drained sites. Black spruce and tamarack are associated with wet sites. Wildfires are common. Larch sawfly has been reported in this section.

M131B Nulato Hills Section: Most of the area supports alpine tundra, but spruce-birch-aspen forests occur at lower elevations. Wildfires are frequent. Bark beetles have been active here.

M131C Kuskokwim Mountains Section: Open black spruce forests are abundant, alpine tundra cover the hills. White spruce - paper birch communities predominate on lower hillslopes. Wildfires are frequent. Defoliators and bark beetles have been observed.

M131D Nushagak-Lime Hills Section: Alpine tundra dominates the rounded to flat topped ridges, and spruce, aspen, and birch prevail in the broad and gentle sloping valleys. Wildfires are frequent. Bark beetles and defoliators have been reported in the past.

135 Alaska Range Taiga Province: This Province is composed of a broad basin surrounded by steep, rugged mountains of the Alaska, Wrangell, and Chugach Ranges. Rivers originate in valley glaciers at high elevations and are often swift and braided with heavy sediment loads. The Copper River is the primary drainage. Forest vegetation includes open black spruce woodlands, with white spruce occurring on better drained soils and along riparian zones in the mountainous Sections.

135A Copper River Basin Section: The basin consists of rolling to hilly moraines and nearly level alluvial plains that occupy the site of a Pleistocene glacial lake. Elevation is 1000 feet or greater. Open black spruce forests are interspersed with large areas of brushy tundra. White spruce occurs on south-facing gravelly moraines. Cottonwood occurs on large flood plains. Fire occurrence is low, and flooding is an important natural disturbance. Damage can include bark beetles, defoliation, and flooding.

M135A Northern Chugach Range Section: Forest vegetation is limited to spruce and hardwoods along the larger rivers. Snow and rock avalanches are common, wildfire occurrence is very low. Damage from bark beetles along river drainages has been reported.

M135B Wrangell Mountain Section: This section is dominated by steep rugged mountains of volcanic origin that have been covered by ice fields and glaciers. Most slopes lack vegetation. Forests of white spruce, birch or aspen occur on broad ridges, valleys, and hilly moraines at lower elevations. Willow and alder are important shrubs. Wildfire occurrence is very low. Defoliators and bark beetles can be active.

M135C Alaska Range Section: Steep mountain ridges are separated by broad valleys, where spruce and hardwood forests occur along riparian zones. Snow avalanches occur frequently, but wildfire occurrence is low. Insect damage reported include bark beetles and defoliation.

139 Upper Yukon Taiga Province: The Province contains the Yukon Flats Section, a flat marshy basin, and the surrounding the rounded mountains and hills. The climate is extreme with large seasonal temperature ranges. Winters are long and cold, and the short summers are hot and dry; some areas at higher elevations are moisture deficit in summer. Wildfire is very common. Permafrost is semi-continuous, and highly subject to alteration from disturbance.

139A Yukon Flats Section: The flat, marshy basin has numerous braided, meandering streams, thaw and oxbow lakes. The lowest parts of the flood plains are poorly drained, but the natural river levees are better drained. Permafrost is present except for beneath rivers and large lakes. White spruce is found on well drained sites, black spruce where drainage is poor. Aspen and poplar occur on flood plains, willow and alder are found in the understory and in the tall scrub communities. Flooding and wildfire are both common. Bark beetles and defoliators can occur.

M139A Ray Mountain Section: Low mountains and hills to the west of the flats. Permafrost, surface water, hillslope, and wildfire interactions result in a complex plant community mosaic. Forests of white spruce, birch, and aspen dominate the lower slopes in the south and south-facing slopes in the north. Black spruce occurs at higher elevations, on north-facing slopes, and all but steep south-facing slopes. Wildfire is very common to frequent. Damage from insects can include bark beetles and defoliators of both conifers and hardwoods.

M139B Ogilvie Mountain Section: Flat-topped hills eroded from former plains and pediment slopes. Karst topography is common. Forest communities occur on lower hillslopes and valleys. Permafrost is common. White spruce grow in well drained

valleys and protected sites. Aspen and poplar are on well drained warmer sites. Mixed forests on poorly drained sites are dominated by black spruce and birch. Wildfire is less common. Defoliators and bark beetles can occur.

M139C Dawson Range Section: This section has steeper rounded ridges with some rugged peaks. Forest vegetation occurs at lower elevations. Open spruce forests are dominated with white spruce, with black spruce sometimes co-dominating. Birch and aspen also occur. Wildfire is very common. Damage reported include bark beetles, larch sawfly, and hardwood defoliation.

200 Humid Temperate Domain: Climate is influenced by both marine and polar air masses.

210 Warm Continental Division: Distinct seasons with snowy winters and warm summers. Needle-leaf forests are common.

213 Alaska Mixed Forest Province: This Province has smooth and irregular plains and surrounded by high mountains. It is centered around Cook Inlet in south-central Alaska. Climate is transitional between polar and maritime. This is reflected in the range of forest cover types: spruce - hemlock to mixed hardwoods. Permafrost is rare.

213A Bristol Bay Lowlands Section: The rolling terrain developed from moraine deposits. Soil texture is coarse near the mountains, becoming finer near the coast. Dwarf scrub communities dominate, but broadleaf and mixed forest stands occur along flood plains. Birch, poplar, white spruce, willow and alder are present. Wildfire occurrence is low. Defoliators are occasional.

213B Cook Inlet Lowlands Section: This broad basin has been shaped by many glacial events. Spruce/hardwood forests are most widespread across the level to rolling plains. Wildfire occurrence from lightning strikes is low, but fires resulting from human activity are very common. This area is heavily populated and has been influenced by agriculture, urban development, petroleum extraction, and human recreation. Damage from bark beetles, defoliators, foliar diseases, and flooding are common. Exotic pests are reported here more than anywhere else in Alaska.

M213A Northern Aleutian Range Section: This section contains steep, rugged mountains of volcanic origin. Large lakes occupy the glaciated valleys. Open spruce forests occur in well drained sites in some valleys and lower hill slopes. Avalanches are common, wildfire occurrence is low. Bark beetles have impacted much of the spruce forests. Cottonwood defoliators can also occur.

M213B Kenai Mountains Section: This Section is dominated by the Kenai and western Chugach mountains. The area has been heavily glaciated. Forest vegetation occurs from mid to low elevations and along rivers and coast lines. Avalanches and flooding are important disturbance events. Wildfire occurrence from lightning strikes is low, but fires resulting from human activity are common. Past land clearing activities, including fire, have influenced the present landscape. Bark beetles and defoliators occur.

240 Marine Division: This zone receives abundant rainfall from maritime air masses. Temperature ranges are narrow due to the marine influence.

244 Pacific Coastal Icefields Province: This Province stretches from the Coast Mountains of southeast Alaska through the St. Elias mountains up to the Chugach-Kenai Mountains. Glaciers and icefields cover the higher portions of the mountains. Rock, ice, and alpine vegetation prevails. The lower elevations support some forests of hemlock and Sitka spruce. Willows and black cottonwood are found infrequently along the glacial river beds.

M244A Chugach Range Section: Alpine vegetation dominates. Forest vegetation is confined to the lowest side-slopes and river bottoms. Hemlock, spruce and cottonwood are predominant. Snow and rock avalanches are common, and flooding events are significant. Wildfire occurrence is very low. Damage from spruce beetle, conifer defoliators, and flooding has been reported.

M244B St. Elias Range Section: Alpine tundra dominates, with forest vegetation confined to river drainages, mostly spruce and hardwoods. Avalanches and flooding are major natural disturbances. Wildfire occurrence is very low. Damage from spruce beetles and defoliators can occur.

M244C Boundary Range Section: This section straddles the international boundary with Canada. Forest vegetation of hemlock, spruce, and cottonwood only occurs along river corridors within mountain passes. Snow avalanches and landslides create large-scale disturbances. Wildfire occurrence is very low. Damage can include defoliators, flooding, spruce beetle, windthrow, and porcupine feeding.

245 Pacific Gulf Coast Forest Province: This Province consists of fjords and mountainous terrain. The Province has the mildest winters in Alaska and abundant precipitation. Hemlock, Sitka spruce, and cedar dominate the coastal rainforests.

245A Gulf of Alaska Forelands Section: The coastal lowlands feature alluvial fans, uplifted mudflats, moraine deposits, and river deltas. Spruce-hemlock forests occur on well-drained sites, whereas alder, willow, and birch dominate wetland areas, with cottonwood occurring along major river channels. Glacial outburst floods and earthquakes causing uplift and subsidence are significant disturbances. Strong winds also influence forest vegetation structure. Wildfire is rare. Damage can include black-headed budworm, spruce beetle, and flooding.

M245A Gulf of Alaska Fjordlands Section: Islands and headlands with steep cliffs from eroded bedrock characterize this section. They support Sitka spruce and hemlock forests. Landslides and avalanches are common and outer islands are subject to intense winds from winter storms. Wildfire is rare. Damage reported includes windthrow, flooding, cottonwood defoliation, conifer defoliation, landslide, spruce beetle, and thinning spruce crowns.

M245B Alexander Archipelago Section: The rugged islands and mountains of southeast Alaska are dominated by rainforests of hemlock, Sitka spruce, and cedar. Wildfires only occur during drought. Landslides and avalanches are frequent in the steeper terrain. The outer islands are subject to extreme winds from winter storms, and so windthrow is common. Other damage includes spruce beetle, conifer defoliation, porcupine damage, and flooding.

References:

Bailey, R.G. 1995. Description of the ecoregions of the United States. 2nd ed. revised and expanded (1st ed. 1980). Misc. Publ. No. 1391 (rev.), Washington DC. USDA Forest Service. 108p.

Bailey, R.G. 1996. Ecosystem Geography. Springer-Verlag New York, Inc. New York, NY. 204p.

ECOMAP. 1993. National hierarchical framework of ecological units. Unpublished administrative paper. Washington DC: USDA Forest Service. 20 p.

Gallant, A.L., E.F. Binnian, J.M. Omernik, and M.B. Shasby. 1995. Ecoregions of Alaska. USGS Prof. Pap. 1567. Washington DC. USDI Geological Survey. 73p.

McNab, W.H. and P.E. Avers. 1994. Ecological Subregions of the United States: Section Descriptions. WO-WSA 5. Washington DC. USDA Forest Service.

Nowacki, G. and T. Brock. 1995. Ecoregions and Subregions of Alaska. USDA Forest Service - Alaska Region. ECOMAP Ver. 2 (map).

APPENDIX E

WORLD WIDE WEB LINKS

Forest insect and disease survey information and general forest health information:

http://www.fs.fed.us/r10/spf/fhpr10.htm
USFS, State & Private Forestry, Forest Health Protection site for Alaska with information on Alaskan insects & diseases, bibliography listing, and links to other Forest Health sites. The section presents a program overview, personnel information, current forest insect and disease conditions throughout the state, forest insect and disease biology, control, impacts, Sbexpert software and other Forest Health issues. This Home Page is periodically updated and is a good source of information on Alaska Forest Health issues.

http://www.dnr.state.ak.us/forestry/index.htm
An Alaska Department of Natural Resources, Division of Forestry home page was assembled in late 1996 for the fire and resource management programs. The site is currently under development but information is available on several of Forestry's programs, including forest health and forest insect surveys. Information will be updated as personnel and funding permit. Users may check the site for information relating to forest health. A link is provided on the home page for accessing forest health and insect survey information and to send an e-mail message. The URL for this insect and disease link is **http://www.dnr.state.ak.us/forestry/res_faq.htm.**

http://www.asgdc.state.ak.us
This is the **State of Alaska, Department of Natural Resources' Geographic Data Clearinghouse site** that is directly patterned and linked to the AGDC site maintained at the U. S. Geological Survey, EROS (Earth Resource Observation Satellite) field office in Anchorage--SEE AGDC link below. The State of Alaska-maintained section of this site contains data layers information in the form of metadata, or "data about the data", that describe the content, quality, condition, and other characteristics of the data. The metadata is compliant with federal geographic data committee (FGDC) standards. For example, data on land status, transportation, physical boundaries—such as coastline, conservation units, etc., and links to state resource information (e.g., forest pest damage surveys, Exxon Valdez restoration data, CIIMMS) and links to other agency forest pest and forest health information and data can be found here. The site is not complete since statewide participation for data submission and access links does not exist at this time, however, the goal is to make this a clearinghouse node for state and local agencies. One example of a clearinghouse node, which does presently exist for data about the Kenai Peninsula that has fairly complete agency participation, is the CIIMMS (Cook Inlet Information Management & Monitoring System) site that can be found at **http://www.dec.state.ak.us/ciimms/**

http://agdc.usgs.gov
The **Alaska Geospatial Data Clearinghouse** is a component of the **National Spatial Data Infrastructure (NSDI)**. The Clearinghouse provides a pathway to find geospatial referenced data and associated metadata. The site is a link to data available from a multiple of federal, state and local agencies. The site is currently administered at the U.S. Geological Survey, EROS field office in Anchorage. From this website the Forest Health Monitoring Clearinghouse can be reached.

http://agdc.usgs.gov/data/projects/fhm
The **Forest Health Monitoring Clearinghouse** provides special resource databases of forest health related information to land managers, scientists, and the general public. Fourteen statewide data layers are available for downloading, including Vegetation/land cover, ECOMAP and Ecoregions, Wetlands Inventory, Timber Harvest and other disturbances, Yearly Insect and Disease Damage, Fire History, Fire Protection Zones, Fire Management Boundaries, Fire Fuels Models, Land Status/Ownership, Elevation, Hydrography, Soils, and Permafrost.

http://www.fs.fed.us/r6/nr/fid/fidls/fidl127.htm
An USDA Forest Service Oregon/Washington Home-page. This is a link to the **FIDL publication #127 on the Spruce Beetle** This publication has been recently revised nationally by the U.S. Forest Service and is available in brochure form.

APPENDIX E

http://www.go2net.org/pest
There is now an **Integrated Pest Management** Technician Home-page. This home-page describes the program and has a wealth of IPM information pertinent to Alaska.

http://www.state.ak.us/local/akpages/FISH.GAME/habitat/geninfo/forestry/INFEST/infesthome.htm
The **Interagency Forest Ecology Study Team (INFEST)** home-page. This site has ecological information pertaining to wildlife and forests, spruce bark beetle, basic silvics, and other Alaska ecosystem considerations.

http://willow.ncfes.umn.edu/fhm/fhm_hp.htm
The **National Forest Health Monitoring** Home Page. Forest Health Monitoring is a national program administered by the U.S. Forest Service and member states. FHM is designed to determine the status, changes, and trends in indicators of forest condition on an annual basis. The State of Alaska provides information to the program, including its annual forest pest damage database, but is not yet a formal member. Links can also be found on this site to other forest health data and program contacts for USFS regional offices and the states that have provided data to the program.

http://www.bugwood.caes.uga.edu
A site maintained by the University of Georgia on forest and **urban pests**, including a good section on **bark beetles**. This is just one example of some of the insect and disease information resources that can be found on the World Wide Web.

http://www.borough.kenai.ak.us/sprucebeetle/default.htm
Kenai Peninsula Borough Spruce Bark Beetle Web Site. This site supplies a direct link to the Kenai Peninsula Borough's Ecosystem Level **Vegetation Mapping Initiative (ELVMI).** This initiative is a vegetation mapping project to provide detailed vegetation mapping information to support fire risk and hazard management in the aftermath of a major spruce beetle epidemic on the Kenai Peninsula. The site gives a progress update on the mapping project, which is designed to produce a forest health/hazard map and GIS data base.

APPENDIX F

INFORMATION AVAILABLE FROM STATEWIDE AERIAL SURVEYS

Each year, forest damage surveys are conducted over approximately 30 million acres. This annual survey is a cooperative effort between U.S. Forest Service, State and Private Forestry, Forest Health Protection (S&PF/FHP) and State of Alaska, Department of Natural Resources, Division of Forestry (AKDNR/DOF) forest health staffs to assess general forest conditions on Alaska's 129 million acres of forested area. About 25% of Alaska's forested area is covered each summer using fixed-wing aircraft and trained observers to prepare a set of sketch-maps depicting the extent (polygons) of various types of forest damage including recent bark beetle mortality, various hardwood and conifer defoliation, and abiotic damage such as yellow-cedar decline. A number of other damage types are noted including flooding, wind damage, and landslide areas during the survey. The extent of many significant forest tree diseases, such as stem and root decays, are not estimated from aerial surveys since this damage is not visible from aerial surveys as compared to the pronounced red topped crowns of bark beetle-killed trees.

In this way, forest damage information is sketched on 1:250,000 scale USGS quadrangle maps at a relatively small scale. For example, at this scale one inch would equal approximately 8 miles distance on the ground. When cooperators request specialized surveys, larger scale maps are sometimes used for specific areas to provide more detailed assessments. Due to the short Alaska summers, long distances required, high airplane rental costs, and the short time frame when the common pest damage signs and tree symptoms are most evident (i.e., usually only during July and August), sketch-mappers must strike a balance to efficiently cover the highest priority areas with available personnel schedules and funding.

Prior to the annual statewide forest conditions survey, letters are sent to various state and federal agency and other landowner partners for survey nominations. The federal and state biological technicians and entomologists decide which areas are highest priority from the nominations. In addition, areas are selected where several years' data are collected to establish trends from the year-to-year mapping efforts. In this way, general damage trend information is assembled for the most significant pests and compiled in this annual Conditions Report. The sketch-map information is also digitized and put into a computerized Geographic Information System (GIS) for more permanent storage and retrieval by users.

Information listed in this Appendix is a sample of the types of products that can be prepared from the statewide surveys and GIS databases that are available. Due to the relatively high cost of mass-producing hard copy materials from the survey data, including colored maps, a number of other map products that are available have not been included with this report. In addition, maps which show the general extent of forest insect damage from 1999 and previous statewide aerial surveys, landowner boundaries, and other types of map and digital data can be made available in various formats depending on the resources available to the user:

Submit data and map information requests to:

Roger Burnside, Entomologist
State of Alaska Department of Natural Resources
Division of Forestry Central Office
Resource Section-Forest Health
550 W. 7th Avenue, Suite 1450
Anchorage, AK 99501-3566
Phone: (907) 269-8460
Fax: (907) 269-8902
E-mail: roger_burnside@dnr.state.ak.us

Kathy Matthews, Biotechnician
USDA Forest Service,
State and Private Forestry, Forest Health Protection
3301 C Street, Suite 522
Anchorage, AK 99503-3956
Phone: (907) 271-2574
Fax: (907) 271-2897
E-mail: kmatthews03@fs.fed.us

APPENDIX F

Map information included in this report: "Forest Insect And Disease Conditions In Alaska -1999"

- **Aerial Detection Survey, Significant Pest Activity,** 11x17 in. format, depicting spruce beetle, *Ips*, larch beetle, larch sawfly defoliation, willow defoliation and cedar decline "hot spots" (color; showing enhanced representation of damage areas).

- **1999 Alaska Forest Damage Surveys Flight Lines and Major Alaska Landownership Blocks** (includes table listing acres surveyed by landowner based on flight lines flown for the 1999 aerial surveys).

- **Kenai Peninsula Region Spruce Beetle Activity 1994-1999**, 8 ½ x 11 in. format, depicting sequential year-by-year spruce beetle activity in south-central Alaska, including the Kenai Peninsula, Cook Inlet area to Anchorage & Talkeetna (includes vegetation base layer).

- **Copper River Region Spruce Beetle Impact**, 8 ½ x 11 in. format, depicting 1999 damage in red and prior damage, 1989-1998 in yellow (includes color shaded relief base showing extent of forest landscape and sample photos of spruce beetle impact).

- **Southeast Alaska Cedar Decline 1999 Aerial Detection Surveys**, 8 ½ x 11 in. format, depicting cumulative Alaska yellow-cedar decline over several years (includes a sample photo of cedar decline. Forested areas are delineated with color shaded relief background)

[Map data for maps provided by USFS/S&PF and AKDNR, Anchorage; cedar decline data provided by USFS/S&PF, Juneau]

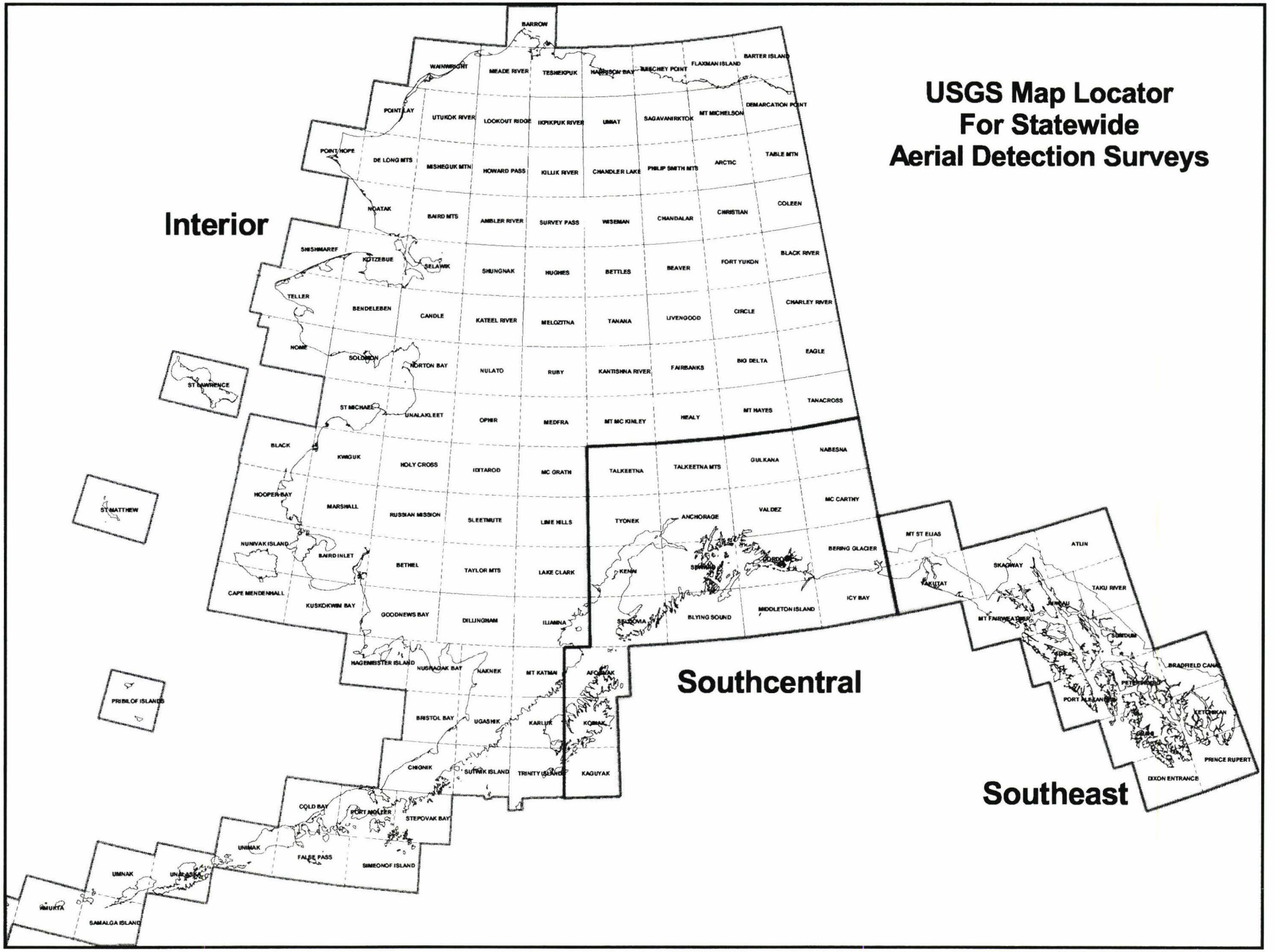
Map and GIS Products Available Upon Request:

1. Digital data file of 1999 forest damage coverage in ArcInfo cover or ArcView shapefile(ESRI, Inc.) format. GIS data files are available at the following URL: **http://agdc.usgs.gov/data/projects/fhm/**.

2. An electronic version of this report, including maps and images, will be available at the Alaska USFS, State & Private Forestry, Forest Health Protection web site (URL: **http://www.fs.fed.us/r10/spf/fhpr10.htm).**

3. Cumulative forest damage or specific-purpose damage maps prepared from AK/DOF or AK USFS, S&PF, FHP geographic information system database.

4. Forest Insect & Disease Conditions in Alaska CD-ROM (includes most of digital forest damage coverages in the AKDNR/DOF database in viewable formats and a copy of the 1999 Alaska Forest Insect & Disease Conditions Report in .pdf format; a fee may be assessed depending on availability of copies and amount of data required for the project).


USGS Map Locator
For Statewide
Aerial Detection Surveys
Interior
Southcentral
Southeast
BARROW
WAINWRIGHT
MEADE RIVER
TESHEKPUK
HARRISON BAY
BEECHEY POINT
FLAXMAN ISLAND
BARTER ISLAND
POINT LAY
UTUKOK RIVER
LOOKOUT RIDGE
IKPIKPUK RIVER
UMIAT
SAGAVANIRKTOK
MT MICHELSON
DEMARCATION POINT
POINT HOPE
DE LONG MTS
MISHEGUK MTN
HOWARD PASS
KILLIK RIVER
CHANDLER LAKE
PHILIP SMITH MTS
ARCTIC
TABLE MTN
NOATAK
BAIRD MTS
AMBLER RIVER
SURVEY PASS
WISEMAN
CHANDALAR
CHRISTIAN
COLEEN
SHISHMAREF
KOTZEBUE
SELAWIK
SHUNGNAK
HUGHES
BETTLES
BEAVER
FORT YUKON
BLACK RIVER
TELLER
BENDELEBEN
CANDLE
KATEEL RIVER
MELOZITNA
TANANA
LIVENGOOD
CIRCLE
CHARLEY RIVER
NOME
SOLOMON
NORTON BAY
NULATO
RUBY
KANTISHNA RIVER
FAIRBANKS
BIG DELTA
EAGLE
ST LAWRENCE
ST MICHAEL
UNALAKLEET
OPHIR
MEDFRA
MT MC KINLEY
HEALY
MT HAYES
TANACROSS
BLACK
KWIGUK
HOLY CROSS
IDITAROD
MC GRATH
TALKEETNA
TALKEETNA MTS
GULKANA
NABESNA
HOOPER BAY
MARSHALL
RUSSIAN MISSION
SLEETMUTE
LIME HILLS
TYONEK
ANCHORAGE
VALDEZ
MC CARTHY
ST MATTHEW
NUNIVAK ISLAND
BAIRD INLET
BETHEL
TAYLOR MTS
LAKE CLARK
KENAI
SEWARD
BERING GLACIER
MT ST ELIAS
ATLIN
CAPE MENDENHALL
KUSKOKWIM BAY
GOODNEWS BAY
DILLINGHAM
ILIAMNA
SELDOVIA
BLYING SOUND
MIDDLETON ISLAND
ICY BAY
YAKUTAT
SKAGWAY
TAKU RIVER
JUNEAU
MT FAIRWEATHER
SUNDURA
GLACIER
BRADFIELD CANAL
PETERSBURG
PORT ALEXANDER
KETCHIKAN
WRANGELL
PRINCE RUPERT
DIXON ENTRANCE
HAGEMEISTER ISLAND
NUSHAGAK BAY
NAKNEK
MT KATMAI
AFOGNAK
PRIBILOF ISLANDS
BRISTOL BAY
UGASHIK
KARLUK
KODIAK
CHIGNIK
SUTWIK ISLAND
TRINITY ISLAND
KAGUYAK
COLD BAY
PORT MOLLER
STEPOVAK BAY
UNIMAK
FALSE PASS
SIMEONOF ISLAND
UMNAK
UNALASKA
AMUKTA
SAMALGA ISLAND

Quadrangle Areas Flown During 1999 Statewide Aerial Surveys:

*Quads with no insect damage for 1999 is marked with an asterisk.

South-central Alaska
Anchorage
Blying sound*
Cordova
Gulkana
Kenai
Kodiak*
McCarthy
Nabesna
Seldovia
Seward
Talkeetna
Talkeetna Mts.
Tyonek
Valdez

Interior Alaska
Ambler River
Arctic*
Baird Mts.
Beaver
Bering Glacier
Bethel*
Bettles
Big Delta
Black River
Candle
Chandalar
Charley River
Christian
Circle
Coleen
Dillingham*
Eagle
Fairbanks
Fort Yukon
Healy
Holy Cross
Hughes
Iditarod
Iliamna
Kantishna
Kateel River
Kotzebue*
Lake Clark
Lime Hills
Livengood
McGrath
Medfra
Melozitna
Mt. Hayes
Mt. McKinley
Nulato
Ophir
Ruby
Russian Mission
Selawik
Shungnak
Sleetmute
Survey Pass*
Tanacross
Tanana
Taylor Mts.*
Unalakleet
Wiseman

Southeast Alaska
Bradfield Canal
Craig
Dixon Entrance
Juneau
Ketchikan
Mt. Fairweather
Petersburg
Port Alexander
Sitka
Skagway
Sumdum
Taku River
Yakutat

Tree damage codes used in 1989-1999 aerial surveys and GIS map products.

* The codes used for 1999 aerial surveys and GIS maps are marked with an asterisk.

ALB	Aspen leaf blight
ALD*	Alder defoliation
ALR	Alder leafroller
ASD	Aspen defoliation
ASF	Alder sawfly
BAP*	Birch aphid
BHB	Black-headed budworm
BHS	BHB/HSF
BID*	Birch defoliation
BLR	Birch leaf roller
BSB	BHB/SPB
CDL	Cedar decline
CLB*	Cottonwood leaf beetle
CLM	Cottonwood leaf miner
COD*	Conifer defoliation
CTB	Conifer top breakage
CWD*	Cottonwood defoliation
CWW	CWD and WID
FIR*	Fire damage*
FLO*	Flooding/high-water damage
HCK*	Hemlock canker
HLO	Hemlock looper
HSF*	Hemlock sawfly
HTB	Hardwood top breakage
HWD	Hardwood defoliation
IPB*	*IPS* and SPB
IPS*	*Ips* engraver beetle
LAB	Larch beetle
LAS*	Larch sawfly
LAT*	Large aspen tortrix
OUT*	Out (island of no damage)
POD*	Porcupine damage
SBM	Spruce/Larch budmoth
SBR*	Spruce broom rust
SBW*	Spruce budworm
SLD*	Landslide
SMB*	Spear-marked black moth
SNA*	Spruce needle aphid
SNR*	Spruce needle rust
SPA	Spruce aphid
SPB*	Spruce beetle
SPC	SPB and CLB
WID*	Willow defoliation
WIR*	Willow Rust
WNT*	Winter damage
WTH*	Windthrow/Blowdown

Note: For all insect activity, the 4th character in the digital data (L, M, or H) denotes intensity. For quantitative descriptors of the intensity levels refer the metadata accompanying the digital data. Digital data can be found at the following URL: http://agdc.usgs.gov/data/projects/fhm/

☆ U.S. GOVERNMENT PRINTING OFFICE: 2000 — 773-484 / 21007 Region No. 8

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, sex, religion, age, disability, political beliefs, sexual orientation, or marital or family status. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, Room 326-W, Whitten Building, 1400 Independence Avenue, SW, Washington, DC 20250-9410, or call (202) 720-5964 (voice and TDD). USDA is an equal opportunity provider and employer.

Federal Recycling Program
Printed on Recycled Paper